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TEACHING AGRICULTURAL MECHANICS IN HIGH SCHOOL.

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A LIST OF 12 CONCEPTS DEVELOPED FOR NEW YORK STATE IN 1958 SERVED AS GUIDES IN PLANNING AND DEVELOPING A COURSE OF STUDY AND TEACHING METHODS IN AGRICULTURAL MECHANICS FOR USE IN THE DAIRYING AREAS OF THE STATE. FORTY PERCENT OF THE TIME IS ALLOTTED TO THE SUBJECT IN AGRICULTURE 1 AND 2 AND 50 PERCENT IN DOUBLE-PERIOD AGRICULTURE 3 AND 4 SUBJECTS. IT WAS DESIGNED TO TRAIN STUDENTS IN MAKING THE DECISIONS AND PERFORMING THE OPERATIONS AND SKILLS NEEDED BY DAIRY FARM OPERATORS. THE MAJOR UNITS ARE--(1) FARM POWER AND MACHINERY, (2) FIELD MACHINERY, (3) FARM SHOP, (4) FARM BUILDINGS AND CONVENIENCES, (5) FARM ELECTRIFICATION, AND (6) SOIL AND WATER MANAGEMENT. THE LEVEL, NUMBER OF PERIODS, AND SEASON IS INDICATED FOR EACH SUBTOPIC. THE PROBLEM-SOLVING AND DEMONSTRATION METHODS OF TEACHING USED IN THIS SUBJECT ARE EXPLAINED. THE USE OF CHARTS AND PICTURES, CONSULTANTS, FIELD TRIPS, VISUAL AIDS, HOME ASSIGNMENTS, AND OTHER TEACHING TECHNIQUES ARE DISCUSSED. SECTIONS ON MANAGING THE AGRICULTURAL MECHANICS SHOP AND TEACHING SAFETY ARE INCLUDED. (EM)

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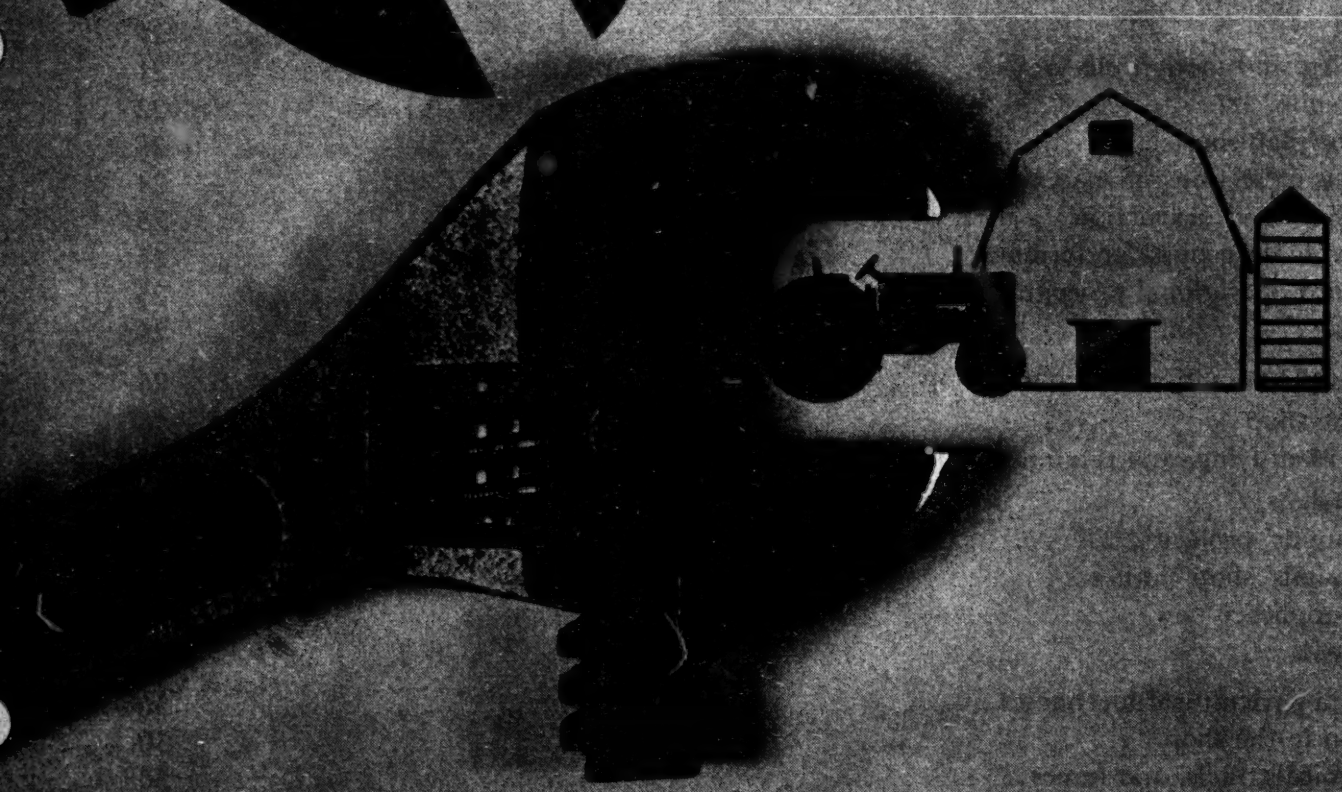

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IN HIGH SCHOOL

BY C. W. HILL

VT 000 053

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TEACHING AGRICULTURAL MECHANICS

IN HIGH SCHOOL

C. W. Hill

Agricultural mechanics is one of the phases of the instructional program in vocational agriculture. Agricultural mechanics along with production of products, marketing, management of the farm business, conservation of resources, development of leadership, and beginning and advancing in farming go to make up a complete instructional program. Each phase of the complete program must be kept in proper relationship to the other, lest one become over-emphasized and cause neglect of the others.

Agricultural mechanics instruction is a part of instructional programs in agricultural education for pupils and young farmers served by the secondary schools. Agricultural mechanics is included in or has content that parallels the instruction in agricultural subjects. Thus, all phases go together to make a complete training program for pupils and young farmers who need and desire it.

GUIDING CONCEPTS IN TEACHING AGRICULTURAL MECHANICS

A list of *12 Guiding Concepts in Teaching Agricultural Mechanics* was developed for New York State in 1958. They serve as guides in planning and developing the course of study and teaching in agricultural mechanics. An understanding of these concepts gives purpose and direction to the instructional program in agricultural mechanics.

1. Agricultural mechanics instruction must be an integral part of the vocational agricultural program and contribute to the training for farming of those enrolled in vocational agricultural classes. This instruction should develop proficiencies in farm mechanics needed by an efficient farm operator.

2. Agricultural mechanics instruction should allow pupils to make managerial decisions and to perform agricultural mechanics operations.

3. A course of study in vocational agriculture should provide preparation for the important mechanical jobs frequently used by farmers. It should be organized by years, taking into consideration the abilities and the readiness of pupils and young farmers.

4. An individual farming program should provide for the performance of agricultural mechanics jobs to be discovered and selected on the farm by the pupil with the help of the parent and/or teacher of agriculture. In the case of young farmers, this selection would frequently involve only the young farmer and teacher.

5. Agricultural mechanics instruction should place emphasis on educational outcomes rather than on service to boys and farmers.

6. Beginners need to learn certain skills before they can do repair work or construct equipment, but these skills should be taught only when they can contribute to the effective performance of jobs.

7. Instruction in the operation, adjustment, servicing, and maintenance of farm power units and field machinery should take precedence over the repair of farm machinery or the construction of farm equipment.

8. For some agricultural mechanics activities, training should be provided through demonstrations and the use of teaching aids provided by the school to prepare the individual to perform on the farm such work as: servicing and repairing water pumps, combines, pick-up balers, and large equipment. This would also apply to the construction of farm equipment and the repair, remodeling, or construction of buildings.

9. The program should include instruction in justifying, selecting, and using farm equipment, machines, and buildings, and the mechanics of soil and water management.

10. Individual on-farm instruction, as well as group instruction, should be given in teaching agricultural mechanics.

11. Field trips to observe, study, or participate in agricultural mechanics activities should be made when they can be conducted with efficient use of time.

12. Instruction should include planning and developing home farm shops.

Many Managerial Abilities and Manipulative Skills are Required to Operate a Modern Farm

Figure 1. The farmer of the future must learn to adjust and to operate farm tractors and field machinery.

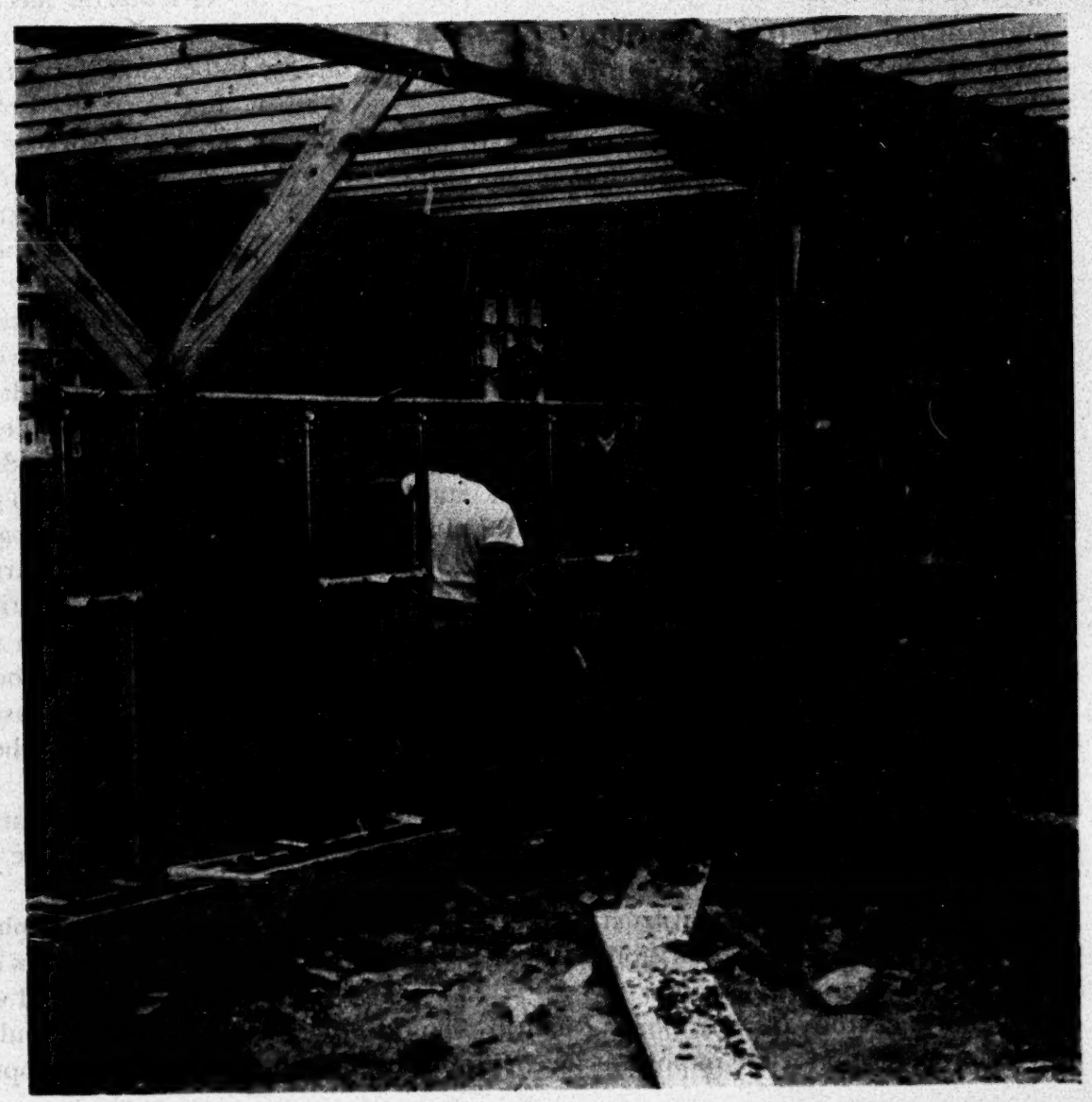

Figure 2. Construction or remodeling of farm buildings requires managerial and operative abilities.

Figure 3. Maintenance of farm tractors is taught in agricultural mechanics

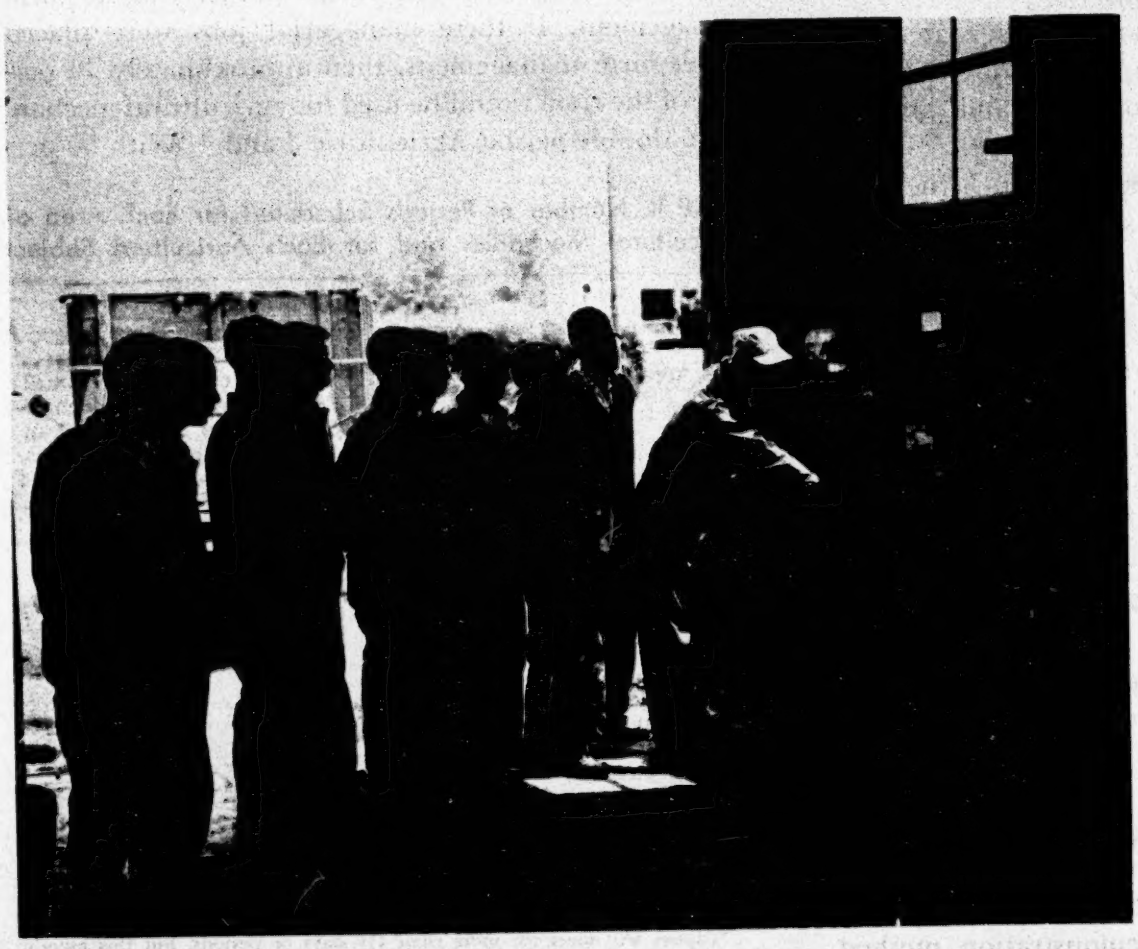

Figure 4. Students learn to control and expand the use of electrical power on the farm.

COURSE OF STUDY FOR AGRICULTURAL MECHANICS

The aim of agricultural education in the secondary school is to provide pupils with training in agriculture.

A training program must be built on the knowledge, attitudes, and skills needed to perform the work of an occupation. The starting point for planning a course in agricultural mechanics is an analysis of the mechanical aspects of farming into the abilities needed by an operator. Any educational or training program must be organized in terms of what the pupils already know, readiness of the pupils, opportunity to learn, and logical sequence. This applies to agricultural mechanics instruction as well as to other phases of agriculture.

The course of study in agricultural mechanics that follows was designed to train pupils in making the decisions and performing the operations and skills needed by dairy farm operators. Since the managerial aspects of farming are just as important as the operative jobs, the pupils should receive instruction in managerial units. This course of study has increased the emphasis on the managerial aspects of farming in agricultural mechanics instruction (figs. 1, 2, 3, and 4).

It has been a practice in secondary school agricultural teaching in New York State for the teacher to plan the course of study for his own school. The proposed course of study in agricultural mechanics on a state level is a departure from this custom, but can be justified for the following reasons:

It is designed for dairying areas of the state.

The purpose of the course is to help the pupils develop the special knowledge and abilities needed in dairy farming.

It is assumed that these needs are much the same from one section of the state to another.

The readiness of the pupils to learn is practically the same throughout the state. There is little variation in their interests and needs, knowledge and skills previously acquired, and physical and mental development.

Although a course of study is proposed, it is assumed that it will be adapted to the needs of the pupils in the local school areas. (See page 10).

Amount of Time Allotted for Agricultural Mechanics

This course is an ambitious program of instruction because the teacher is challenged to make the most efficient and effective use of his teaching time. To be successful he should: carefully evaluate the amount of time allotted to each job, make the most efficient use of this time, and select effective methods and techniques of teaching to achieve the maximum amount of learning. The use of the demonstration method should result in more effective teaching of a larger number of jobs. Learning jobs at home under the supervision of the teacher or parents should coincide with classroom instruction so that the pupils learn in school and then apply the learning to jobs or problems on the farm. This is not suitable for all types of work; there are some jobs that pupils should do only at school under close supervision.

TABLE I. Number of Periods and Percentage of Time Allotted for Agricultural Mechanics in Each Subject

Subject	Total number of periods	Percentage of time
Agriculture 1	68	40
Agriculture 2	68	40
Agriculture 3 (Double period class)	170	50
or		
Agricultural Mechanics 1 (Single period class)	170	100
Agriculture 4 (Double period class)	170	50
or		
Agricultural Mechanics 2 (Single period class)	170	100

The course of study is set up on the basis of 40 percent of the time allotted to agricultural mechanics in Agriculture 1 and 2 and 50 percent in double-period Agriculture 3 and 4 subjects (table I). The amount of time for agricultural mechanics in double-period Agriculture 3 and 4 is high, but it should be recognized that many managerial jobs are in the agricultural mechanics course of study in the third and fourth year. Most likely, these would have been placed formerly under farm management. If these managerial jobs were placed under farm management, then approximately 40 percent of the time would be used for agricultural mechanics in double-period Agriculture 3 and 4. With 50 per-

TABLE II. Number of Periods Scheduled for Each Area of Agricultural Mechanics and for Each Agriculture Subject

Area	Total no. periods	Agricultural subjects			
		Agriculture 1	Agriculture 2	Agricultural Mechanics 1 or Agriculture 3	Agricultural Mechanics 2 or Agriculture 4
Farm power and machinery					
Tractors and engines	85	15	0	64	6
Field machinery	103	0	13	0	90
Farm shop	159	48	51	22	38
Farm buildings and conveniences	75	0	4	54	17
Farm electrification	30	0	0	30	0
Soil and water management	24	5	0	0	19
Totals	476	68	68	170*	170*

*Classes will meet for more than 170 days or periods, but this amount is scheduled so as to allow time for tests, examinations, special activities, etc.

cent of the time given to agricultural mechanics in double-period Agriculture 3 and 4, the total amount of time alloted for agricultural mechanics is the same in Agricultural Mechanics 1 and 2. Therefore, the same course of study may be used.

Number of Periods Scheduled for Each Area in Each Subject

The amount of time scheduled for each of the areas of agricultural mechanics is given in column 1 of table II. Farm tractors and engines and field machinery are scheduled for 85 and 103 single periods, respectively. Farm shop jobs use 159 single periods. Farm buildings and conveniences are assigned 75 periods. Farm electrification and soil and water management are scheduled for 30 and 24 periods, respectively (table II). The number of periods needed to teach the jobs under each of the areas in agricultural mechanics is listed in the second column, under Agriculture 1. Almost all the time in Agriculture 1 is given to farm shop, with 15 periods to tractors and engines. In Agriculture 2, still most of the time is scheduled for farm shop, with 13 periods for field machinery. Much of the work in farm shop in Agriculture 1 and 2 is elementary, yet develops basic knowledge and skills needed for work in the last two years.

In Agricultural Mechanics 1 or Agriculture 3, major emphasis is given to tractors and engines, with 64 periods, and farm buildings and conveniences are scheduled for 54 periods. Farm electrification and farm shop are scheduled for 30 and 22 periods, respectively. Approximately one-half of the time in Agriculture 4 or Agricultural Mechanics 2 is scheduled for field machinery. The remainder of the time is distributed between farm shop, farm buildings and conveniences, soil and water management, and tractors and engines.

Suggested Course of Study for Agricultural Mechanics in Schools in Dairying Areas of New York

Job	Agriculture 1		Agriculture 2		Agricultural Mechanics 1 or Agriculture 3		Agricultural Mechanics 2 or Agriculture 4	
	Periods*	Season†	Periods	Season	Periods	Season	Periods	Season
I. Farm Power and Machinery								
A. Tractors and Engines								
1. Operating engines and tractors safely	5	S						
2. Using the operator's manual and keeping records of service and fuel consumption	3	S						
3. Principles and operation of internal combustion engines					4	W		
4. Lubricating tractor wheel bearings, differential, steering, etc. (Kinds of lubricants)	4	W						
5. Servicing crankcase, oil filters and air cleaners	3	W						
6. Servicing hydraulic systems					3	W		
7. Selecting and servicing batteries					3	F		
8. Servicing magnetos and distributors					5	F		
9. Selecting and servicing spark plugs					2	F		
10. Servicing and adjusting carburetor and air-fuel system					5	F		
11. Servicing starters, generators, and lights					5	W		
12. Adjusting clutch					3	W		
13. Adjusting mechanical and hydraulic brakes					5	W		
14. Adjusting valves					5	W		
15. Trouble shooting (compression, electrical, fuel, etc.)					3	S	3	S
16. Servicing steering system					4	W		
17. Selecting, caring for and repairing tires and tubes							3	W
18. Servicing cooling system					3	F		
19. Winterizing					5	F		
20. Selecting tractors and engine units					7	S		
21. Preparing for and storing tractors and engines					2	F		
Units to teach after the above units have been taught or learned by the pupils:								
1. Replacing clutch								
2. Grinding valves								
3. Overhauling engine								
4. Repainting tractor								
Total number of single periods	15		0		64		6	
B. Field Machinery								
1. Assembling new manure spreader			9	W				
2. Lubricating, operating, and adjusting manure spreader			2	W				
3. Lubricating, operating, and adjusting mowing machine			2	S				

*Periods = Number of single periods.
†Season = Season of the year (F = Fall; W = Winter; S = Spring).

Job	Agriculture 1		Agriculture 2		Agricultural Mechanics 1 or Agriculture 3		Agricultural Mechanics 2 or Agriculture 4	
	Periods	Season	Periods	Season	Periods	Season	Periods	Season
4. Reconditioning a cutter bar (mower, forage harvester, combine, etc.)							5	S
5. Lubricating, operating, and adjusting forage harvester							4	F
6. Lubricating, operating, and adjusting a baler							5	S
7. Sharpening and adjusting knives and shear plates (forage harvesters and balers)							3	F
8. Checking plow for sprung parts and making necessary repairs							4	F
9. Making proper field adjustments on plow							4	F
10. Selecting seed plates, calibrating and operating corn planters							3	S
11. Operating, calibrating, and cleaning grain drill							5	S
12. Operating and maintaining weed sprayers							2	S
13. Calibrating a weed sprayer							2	S
14. Preparing for and storing field machinery. (Suggested: grain drill, plow, corn planter, baler, weed sprayer, fertilizer spreader, etc.)							5	S
15. Providing economic and adequate mechanization for our farms							5	F
16. Selecting an individual piece of equipment (baler, forage chopper, or other machine)							3	S
17. Construction and reconditioning							40	W&S
a. Replacing or repairing broken or worn parts. (Suggested: manure spreader, grain drill, baler, forage harvester and/or other machines)								
b. Construction. (Suggested: farm trailer, weed sprayer, mount weed sprayer on trailer, snow plow, etc.)								
Units to teach after the above units have been taught or learned by the pupils:								
1. Adjusting a combine								
2. Adjusting row crop cultivators								
3. Buying used farm equipment or truck								
4. Operating self-propelled machinery								
5. Selecting, maintaining, and using a chain saw								
6. Adjusting and operating disc and harrows								
Total number of single periods	0		13		0		90	
II. Farm Shop								
1. Shop organization, safety, and regulations	3	F	1	F	1	F	1	F
2. Reading and sketching plans	3	F						
3. Figuring bill of material	2	F						
4. Selecting and buying material			2	F				
5. Identifying and using hand tools	2	F						
6. Fitting tools (twist drill, auger bit, screwdriver, axe, cold chisel, etc.)	5	W						
7. Selecting and truing grinding wheels	1	F						
8. Tieing common knots and hitches (finishing ends)	3	W						
9. Replacing handles	2	W						
10. Care and safe operation of portable power tools (drill, hand saw)			1	W				
11. Care and safe operation of stationary power tools	2	S						
12. Developing farm carpentry skills through building:								
a. Saw horses, show trunk, etc	10	W						
b. Feed cart, individual calf pen, etc			12	W				
c. Feed bunk, trailer body, or forage box, etc							20	W
13. Identifying kinds, types, and uses of metal					1	W		
14. Developing metal working skills:								
a. Measuring, filing, drilling, bending	2	S						
b. Screw extractor, use of tap and die			2	W				
15. Soldering holes, patches, seams	2	S						
16. Oxy-acetylene welding—EMPHASIZE SAFETY in all operations:								
a. Setting up welding equipment			1	F				
b. Lighting and shutting down torch			2	F				
c. Cutting			1	F				
d. Heating, bending, and tempering			2	S				
e. Welding mild steel			3	F				
f. Bronze welding of cast or malleable iron			3	W				
g. Hardfacing			1	S				
17. Electric arc welding:								
a. Setting up and operating equipment	1	S						
b. Striking an arc and running bead	3	S						

Job	Agriculture 1		Agriculture 2		Agricultural Mechanics 1 or Agriculture 3		Agricultural Mechanics 2 or Agriculture 4	
	Periods	Season	Periods	Season	Periods	Season	Periods	Season
c. Welding mild steel, flat position	4	S	4	F				
d. Cutting metal			1	S				
e. Uses of carbon arc torch			2	S				
f. Hardfacing			3	S				
g. Welding cast iron					3	W		
h. Selecting electrodes					1	W		
18. Welding, arc and oxy acetylene—repair and construction			5	S	8	W	10	W
19. Painting:								
a. Selecting and storing material	1	W						
b. Painting and cleaning brushes	1	W						
c. Method of application	1	W						
d. Cleaning, adjusting, operating, paint sprayer					3	S		
e. Use of wood preservatives					1	W		
20. Planning the home farm shop:								
a. Location and layout			2	W				
b. Storage of tools and supplies			3	W				
c. Selecting tools and equipment					2	W		
21. Identifying kind, types, and use of plumbing materials							1	W
22. Measuring, cutting, threading, and assembling iron pipe							2	W
23. Measuring, cutting, bending, flaring, and sweating copper tubing							1	W
24. Measuring, cutting, and connecting plastic pipe							1	W
25. Repairing leaky valves and faucets							2	W
Total number of single periods	48		51		22		38	
III. Farm Buildings and Conveniences								
1. Planning long-term farmstead improvements (Machinery storage, building location, driveways, etc.)					3	W		
2. Farm building maintenance, repair, and painting (windows, floors, roofs, doors, etc.)					3	F		
3. Selecting and maintaining silos					2	S		
4. Planning buildings to meet needs, including efficiency (milking parlors, milk house, barns, tool sheds, grain storage, etc.)					10	S		
5. Selecting materials for farm buildings (roofing, siding, kind of materials, etc.)					2	S		
6. Laying out a foundation and building forms					4	S		
7. Selecting materials, mixing, pouring, and finishing concrete					4	S		
8. Selecting and using masonry construction					4	S		
9. Planning and constructing building framing and rafters					3	S		
10. Protecting farm buildings and equipment from common hazards (wind, lightning, fire, freezing, etc.)					2	S		
11. Ventilating dairy barn					5	F		
12. Operating and servicing milking equipment:								
a. Pulsators			2	F				
b. Vacuum lines and pumps					4	F		
13. Selecting milk handling equipment (machines, pipelines, bulk tanks, coolers, etc.)					3	S		
14. Selecting and servicing materials handling equipment for labor efficiency including: barn cleaner, conveyors, silo unloader, etc.					5	F		
15. Selecting, servicing, and operating farm water systems							5	F
16. Maintaining the farm sewage and drainage systems							2	F
17. Providing for surface and building drainage around farmstead							2	F
18. Building and maintaining farm fences and gates (permanent, temporary, electric, etc.)							4	S
19. Selecting, caring for, and maintaining crop dryers							2	S
20. Improving home grounds			2	S			2	S
Total number of single periods	0		4		54		17	
IV. Farm Electrification								
1. Understanding electrical terms and concepts					3	F		
2. Fusing, over-load protection, and safe use of electricity					3	F		
3. Wiring circuits, outlets, and fixtures					5	F		

Job	Agriculture 1		Agriculture 2		Agricultural Mechanics 1 or Agriculture 3		Agricultural Mechanics 2 or Agriculture 4	
	Periods	Season	Periods	Season	Periods	Season	Periods	Season
4. Planning for adequate farm wiring and distribution system					6	W		
5. Selection and types of electric motors					4	S		
6. Installing and protecting electric motors					4	S		
7. Maintaining and caring for electric motors					5	S		
Total number of single periods	0		0		30		0	
V. Soil and Water Management								
1. Measuring and mapping land	5	F						
2. Planning for adequate farm water supply							5	F
3. Technical services available from Soil Conservation Service							3	F
4. Planning and using diversion ditches, strips, and/or grass waterways							3	F
5. Planning and using farm ponds							5	F
6. Planning and using drainage systems							3	F
Units to teach after the above units have been taught or learned by the pupils:								
1. Farm irrigation systems								
2. Flood control								
3. Streambank stabilization								
Total number of single periods	5		0		0		19	

Adapting Agricultural Mechanics Course of Study to the Local School

This course of study is suggested primarily for schools in dairying areas. Schools in other farming areas may find much that coincides with or is needed in the training program for pupils in their schools, but the sections on field machinery and farm buildings and conveniences would require revision. Before accepting all or part, whether a school is located in a dairy or other type of farming area, it would be a good policy to consult with the school administrator and the advisory board. The following procedure may be a guide to revising the local course of study:

Discuss with school administrator suggested course of study and advisability and procedure for revising local course of study.

At an advisory board meeting, consult with members about advisability of revising local course of study, taking into consideration the following:

Need for training in agricultural mechanics.

Contributions made by present course of study to training needs of pupils.

Contributions that may be made by suggested course of study.

Review five major areas and jobs under each.

Consider relative importance of each major area and amount of time alloted to each.

Then, obtain suggestions for revising local course of study.

Agriculture teacher should plan local course of study, taking into consideration training needs of pupils.

Agricultural mechanics phase of program should be integrated with other agricultural units in Agriculture 1, 2, 3, and 4.

After course of study has been developed by teacher, it should be presented to school administrator and advisory board for evaluation.

GUIDING PUPILS IN PLANNING AGRICULTURAL MECHANICS PHASE OF FARMING PROGRAMS

The individual farming program is an effective way of developing in pupils the ability to make managerial decisions and acquire skills. The well-established principle of learning to do by doing (participation and practice) is fundamentally sound and usable in teaching pupils the agricultural mechanics phases of farming. Therefore, pupils must have the opportunity and responsibility to make decisions and perform operational jobs.

The course of study can be used as a guide by the teacher in planning the pupils' individual farming programs. The jobs in Agriculture 1 indicate what pupils may do for their farming programs. The teacher could use the same system for other subjects.

The procedure in planning the agricultural mechanics phase of the individual farming programs is no different from the other phases. First, it is desirable to know the parents as well as the boy, and for them to know the teacher. A visit to the farm will help achieve this purpose. Second, the parent and boy should know the purpose of the instructional program in agricul-

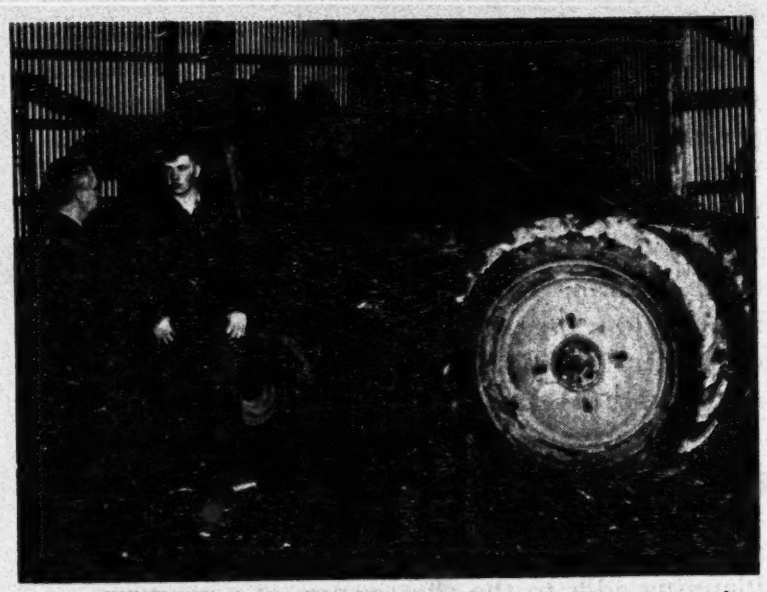

Figure 5. The teacher guides the pupil in selecting and in planning his individual farming program.

tural mechanics and some knowledge of the instructional content. Third, during the summer before school begins, the teacher should walk over the home farm with each boy to select the jobs to be included in his farming program (fig. 5). As the teacher walks around with the boy, he determines what the boy has learned to do, his interests, and what opportunities there are for him to do the jobs in the current course of study. Once the pupils and teacher have selected the jobs for the farming programs, they should talk with the parents. Fourth, the teacher needs to arrange with the parent for the pupil to do the jobs selected (fig. 6). The parent may be willing for the son who is in Agriculture 1 to take complete responsibility for fitting the hatchet, chisels, augur bits, screw drivers, and cold chisels but not be willing to give complete responsibility for lubricating tractor wheel bearings, servicing the air cleaner and oil filter. However, he might agree to give the son responsibility for these jobs on a shared basis. Junior and senior students who have previously assumed responsibilities and demonstrated their abilities to parents can arrange with their parents for additional responsibilities. This practice should be promoted with the sons and the parents. After the parents have agreed to give the pupils responsibility to do the jobs, the next step is for the pupils to record them on *My Farming Program sheets.* (Do not just record jobs from the course of study.)

In planning with pupils for farming programs and working out arrangements with parents, the teacher needs to keep these factors in mind: the scope of the job, ability of the boy, difficulty of the job, dependability of the boy, faith and trust placed in the son by the parents, and cooperativeness of the parents. Pupils in Agriculture 1 and 2 need assistance from the teacher in arranging with parents for farming programs, whereas older, experienced pupils are more or less able to plan and work out arrangements with parents on their own.

An organized instructional program can be developed to the extent that the pupils have the same jobs in their farming programs as in the subjects they are currently studying. But not all the jobs that boys need to learn will be in a four-year course of study. Those jobs not in the course of study but which the pupils need to learn should become a part of the farming programs. These jobs may be taught in school or on the farm (fig. 7).

Figure 6. The teacher arranges with the parent for the pupil to have responsibilities for managerial and operative jobs on the home farm.

Figure 7. An Agriculture 4 student is building a home farmshop with the teacher of agriculture giving instruction.

Suggested Experiences for Agricultural Mechanics Phase of Farming Programs

The material below constitutes a sample and partial listing of the experiences that boys in Agricultural Mechanics 1 might plan for in their farming programs. Presumably, before any activity is listed in the farming program, a boy, his father or employer, and his teacher, individually or jointly, have made arrangements for the boy to actually experience the activity. The sample that follows merely suggests the format in which agricultural mechanics experiences in a farming program may be shown and does not represent the experiences any one boy may obtain.

FORMAT TO ILLUSTRATE AN INDIVIDUAL FARMING PROGRAM

Jobs	Scope	Degree of responsibility	Month to prepare written plan
Farm machinery maintenance and repairs I will perform:			
1. Servicing spark plugs	3 engines	complete	
2. Servicing distributor	2 engines	complete	
3. Servicing and adjusting carburator and air-fuel system	Farmall H	shared	
4. Servicing the cooling system	3 engines	complete	
5. Winterizing	2 tractors	complete	
6. Servicing generator	Farmall H	complete	
7. Buying a new tractor	one	shared	March
Other farm equipment maintenance, construction, or repairs I will perform:			
1. Cleaning milker vacuum pipes	both lines	complete	
2. Install electric outlet in milk house	one	shared	
3. Buying power handsaw for shop	one	shared	February
4. Cleaning and lubricating electric motors	5 motors	shared	
5. Selecting an electric motor for hay conveyor	one	shared	May
6. Buying a bulk tank	one	shared	May
Farm building maintenance, remodeling and construction I will perform:			
1. Replacing and glazing barn windows	5 windows	complete	
2. Installing ventilating fans in barn	two	shared	November
3. Building hay rack for calves	one	complete	February
4. Buying ready-mixed concrete	farm shop floor	shared	April

AGRICULTURAL MECHANICS UNITS IN THE TEACHING CALENDAR

The teaching calendar is the functional planning instrument for selecting and recording, in chronological order and for each class, the jobs or units to be taught during the year. A number of factors enter into planning the teaching calendars for each of the classes. Briefly these factors are: providing an organized instructional program; providing a broad, complete program; using time efficiently so as to teach more units; providing for individual differences; teaching all members of class with limited facilities; planning instruction in each class so that the shop is free when space is needed for large projects or equipment in advanced classes; finding time to teach the applied science or information; the pupils' farming programs and course of study. It would be wise to examine each of these factors as they relate to planning the teaching calendar.

The instruction in agricultural mechanics is an organized and planned program. The units must be selected and scheduled on a logical and seasonal basis according to needs, interests, and abilities of the pupils. Planning adds to the effectiveness of a program.

A high quality program in agricultural mechanics is dependent upon a broad selection of experiences in managerial and skill jobs in all the five areas delineated in the course of study. This type of program will be successful to the extent that it is planned for in each of the subjects.

Efficient use of time is partially dependent upon the selection of an effective method of teaching. The demonstration method is generally the least time-consuming but the most effective and efficient way to teach skills. Applied science can be given along with the demonstration, and supplemental information can be assigned for study outside of class. In teaching managerial jobs, confine the class instruction to the decisions that pupils face in performing the job.

Efficiency in the use of class time is also related to the degree of skill to be developed by the pupils. It is not the intent in agricultural mechanics instruction to develop craftsmen, but high school pupils can learn much about many skills and how to perform them with a fair degree of proficiency. Those who have the interest and aptitude can further improve their skills outside of class.

The need to learn and the rate of learning are not the same for all pupils. So, in planning the teaching calendar, provisions should be made for the class to work in small groups on different jobs, or some jobs should be scheduled for only certain individuals while other pupils work as a group.

Where facilities are limited, it is not possible to schedule all the jobs to be taught one at a time. Rather, it will require that two, three, or four jobs be scheduled concurrently. As the students learn one job, proceed to the next one.

Classes may be scheduled for alternate use of shop facilities. This factor should be given careful consideration in planning the teaching calendar. When the Agriculture 4 class is working on field machinery, the shop

may be crowded and little floor space available for the Agriculture 2 class to construct projects. In small shops, the Agriculture 1 and 2 classes will have more space and less confusion by scheduling instruction in the shop at different times. By alternating the classes, this room will be in use throughout the year.

The problem arises with teachers as to how much information to teach and how much time to schedule. In the teaching of managerial jobs, for example, the boys should learn the information needed to make intelligent decisions. For operational or skilled jobs, the pupils need to know the how and the why. Generally, the applied information should be taught along with the demonstration. Outside assignments can supplement the information learned in class. Some homework of this nature should be included in the instructional program.

It is not always possible or desirable for all pupils to have adequate practice at school in every activity taught in agricultural mechanics. After observing a good demonstration and practicing in class, the pupil should continue the job at home. It should be emphasized that, whenever possible, the pupils obtain practice and improve their skills on the home farm. This will require individual on-farm instruction by the teacher (fig. 8).

The course of study is the starting point in planning for the units to be taught in a subject, and it serves as a guide in planning the individual farming programs. Then, the jobs in the farming programs go to the teaching calendar (fig. 9). Certain jobs in the course of study that are not in the farming programs are taken directly from the course of study to the teaching calendar. The teaching calendar for Agricultural Mechanics 1 and 2 would contain only jobs in agricultural mechanics. The agricultural mechanics jobs would make up only a portion of the teaching calendar for Agriculture 1 and 2 and the double period Agriculture 3 and 4.

Figure 8. The teacher of agriculture follows school teaching with individual on-farm instruction. This student is learning to hardface plow shares.

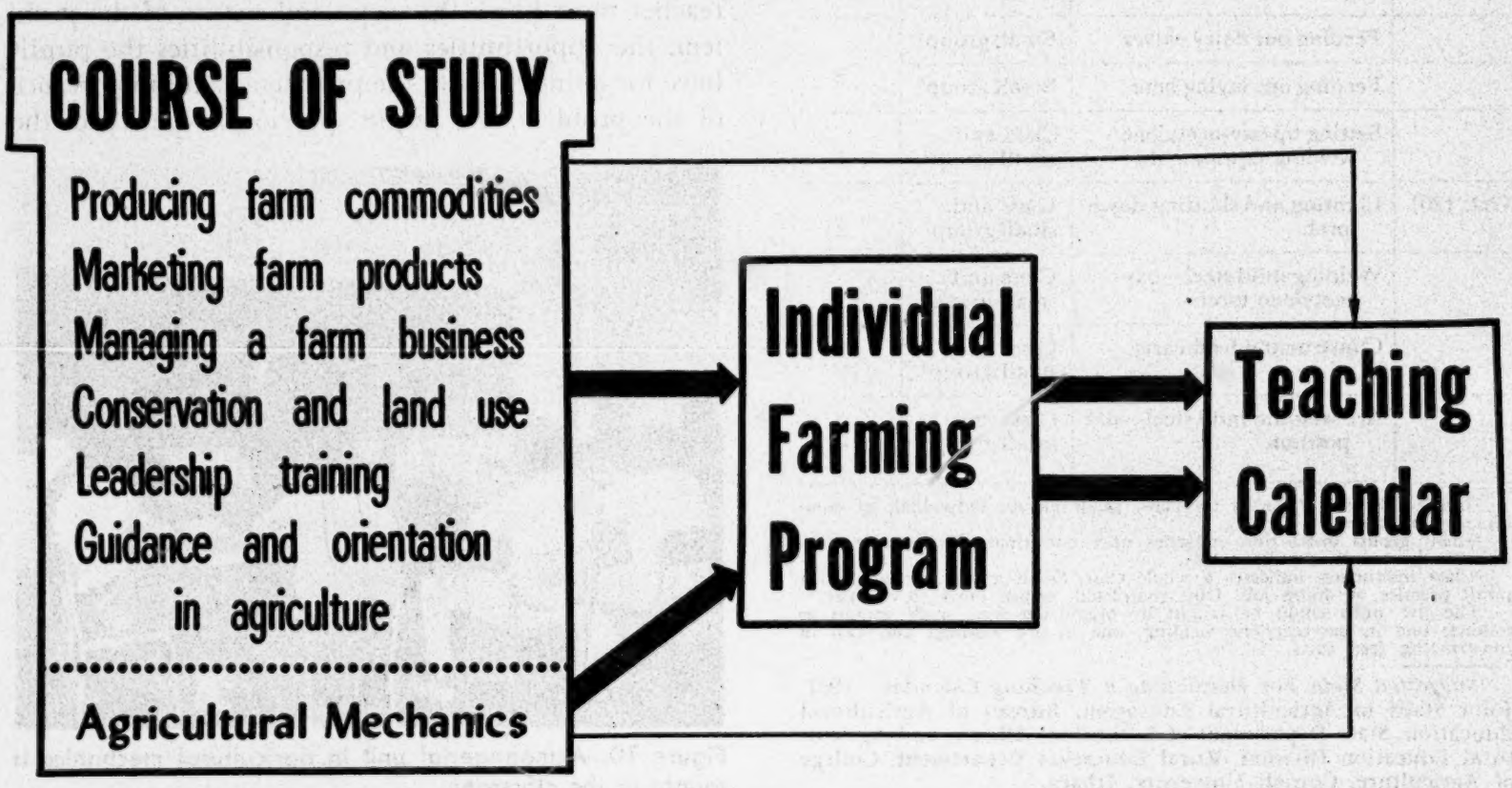

Figure 9. Relationship between the course of study, the individual farming program and the teaching calendar.

Suggested steps for developing a teaching calendar[1] are as follows:

Using the course of study and the pupils' farming programs as a basis, make a selection of those units to be taught during the year, taking into consideration:

Number of farm jobs or problems included most often in the pupils' farming programs. These should be given priority in the calendar.

Available facilities. Be sure facilities are available for jobs to be included.

Available time. Calculate number of periods classes will be in session for each calendar month.

Time needed to teach each job. Calculate basis of time alloted for jobs in course of study as well as nature of jobs.

Pupil needs. Knowledge and skills to be taught. Responsibilities pupils have for doing the jobs.

Arrange units for each year into a teaching calendar, taking into account such factors as timeliness, economic importance, logical sequence, and urgency.

For each job to be taught, indicate type of instruction to be used.

Revise teaching calendar (table III) as need arises.

TABLE III. Example of Teaching Calendar for Agriculture 2 Class

Month and no. of teaching days	Unit to be taught	Type of instruction[1]	Periods alloted
Sept. (14)	Planning my farming program	Class	3
	Feeding our dairy calves	Small group[2]	5
	Feeding our laying hens	Small group[2]	
	Setting up oxy-acetylene welding equipment	Class and small group[3]	1
Oct. (20)	Lighting and shutting down torch	Class and small group[3]	2
	Welding mild steel—oxy-acetylene torch	Class and small group[3]	3
	Constructing feed carts	Class and small group[3]	10
	Arc welding mild steel—flat position	Class and small group[3]	4

[1]Indicate if instruction is for class, small group, individual, or combination of these.

[2]Small group instruction indicates only one time allotment for two units to be taught simultaneously.

[3]Class instruction indicates a whole class. Small group instruction for pupil practice or doing job. Unit completed, pupils move to another.

The five units could be taught by organizing four small groups as follows: one in oxy-acetylene welding, one in arc welding, and two in constructing feed carts.

[1]*Suggested Steps For Developing a Teaching Calendar.* 1957. Joint Staffs in Agricultural Education, Bureau of Agricultural Education, State Department of Education, Albany, and Agricultural Education Division, Rural Education Department, College of Agriculture, Cornell University, Ithaca.

METHODS OF TEACHING

The Problem-Solving Method of Teaching

The problem-solving method of teaching is the process by which the teacher guides and directs the pupils in: recognizing a problem (a job to learn), identifying the decisions and factors, obtaining information, selecting and testing the alternative(s), and arriving at a solution. The problem-solving method can be used with agricultural mechanics units where selection and/or management decisions are involved—where choices have to be made between alternatives (fig. 10). This method applies to jobs such as: buying tractor tires, purchasing a forage chopper, or planning for an adequate farm water supply. The method does not apply to units such as: lubricating the chassis of a tractor, sharpening a twist drill, brazing cast iron, or adjusting the tappets in an engine.

Preparation for Teaching a Managerial Job

These are the steps a teacher should take into consideration in planning for teaching a managerial job.

State the specific problem to be solved. The job must be identified on the basis of a single unit and expressed as a farmer would say it. A sample problem might be: selecting harvesting equipment, ventilating the dairy barn, or purchasing a water pump or a tractor. The problem or job should be stated in words familiar to boys and in such a manner that it involves a limited number of decisions.

Become oriented to the teaching situation. The teacher must know the scope and nature of the problem, the opportunities and responsibilities the pupils have for doing the job, the prevalence and importance of the problem, the pupils' previous experience, the

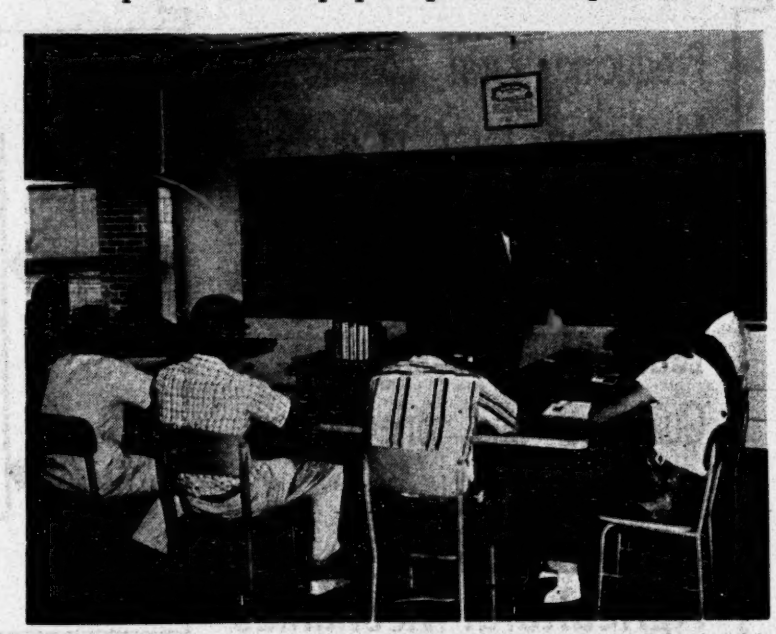

Figure 10. A managerial unit in agricultural mechanics is taught in the classroom.

practices used on the home farm, and the facilities available for teaching. Also, the pupils' interests and attitudes affect the teaching procedures.

Determine the teaching objectives. The teacher must anticipate and plan the change desired in the pupils' behavior or the outcome of the pupils' efforts. The teacher's objectives in dealing with managerial jobs should be to develop in the pupils the ability to make those decisions necessary to a particular job. A specific example may be observed in the teaching plan that follows.

Analyzing the job into: decisions and *factors.* This step will result in an outline of the content needed to achieve the objectives. The decisions will be an outgrowth of the objectives. Only those decisions in which the pupils will be directly involved should be considered. The teacher should be guided in making the analysis by his orientation to the teaching situation and by the teaching objectives.

A decision involves alternatives that must be selected and tested. In testing the alternatives, certain factors that serve as guide posts in assembling information must be identified. This may be illustrated in deciding which variety of corn to buy. Some of the factors are: yield, standing ability, disease resistance, and length of growing season. Information must be collected on possible varieties for each of the factors. Then, after evaluating the alternatives on the basis of the information collected, a variety can be selected.

Planning the Teaching Procedures

The teaching procedures should outline the student-teacher activities (teaching techniques) that will guide the pupils toward a solution to the problem (practices to use). The procedure would require these steps:

Introducing the unit by orienting the pupils to the situation as outlined above under orientation to the teaching situation. The purpose of this is to help the pupils recognize and accept the problem or job as it exists on their farms. This may be done by class discussion, by field trip to study the problem on a number of farms, or by pupils individually surveying farms to observe practices. Experimental data or information from the College of Agriculture might present further differences in practices or results.

Analyzing the job into the decisions to be made. The teacher should plan the procedure for this. The amount of assistance the pupils need will depend upon their age, experience, and capacity for responsibility. The decisions should be quickly presented to the class by the pupils and/or the teacher. The decisions should be arranged in logical sequence.

Identifying factors. After all of the decisions have been presented, the teacher and pupils should identify the factors for each of the decisions. Older boys with experience and those who are acquainted with the problem should be able to state the factors; the younger boys will need help. If the pupils do not recognize the factors, the teacher should state and record them. Then, the decisions and factors should be recorded by the pupils also for use in obtaining information, arriving at decisions or practices, and writing up their farm job plans.

Obtaining information for each of the factors. The teacher will select the techniques for presenting the information. The (applied) science and knowledge that relate to the factors should be presented by the teacher or sought out by the pupils. A variety of techniques may be employed, each when it will be most effective. Selected teaching techniques are presented later in this publication.

Directing pupils in a choice of action for each decision. The teacher should lead the pupils to selecting an alternative and justifying it with the facts. The entire class deals with a problem, then each boy individually works out a solution for his own case. The facts are to be brought out only as they relate to the decision and factors. It is not desirable to review information just to learn facts for facts' sake.

Guiding pupils in writing up an individual farm job plan. Actually, in the steps above, the pupil arrives at the essence of his plan, which should contain the what, how, and when of the managerial jobs for which he is responsible. The decisions serve as a guide to the pupil in writing up his plan. The pupil must be able to justify anything in his plan. After the pupil has written up the plan, the teacher checks it to see that it is acceptable. Once the pupil has a satisfactory plan, it should be taken home for parental approval.

A teaching plan illustrating the problem-solving method of teaching is given below.

A Suggested Teaching Plan

Area: Farm buildings and conveniences.
Job: Selecting and purchasing a bulk tank.
Situation: A unit has been taught on methods for handling milk.

It was decided that the bulk tank method could be justified for certain individual farms represented in the class.

Two of the ten boys in Agriculture 3 class have been given the responsibility by their fathers of assisting in the selection and purchase of a bulk milk tank. Three other dads and sons have been discussing the possibility of converting to bulk tanks. The size of the herds ranges from 30 to 60 milkers.

Objectives: To develop in the pupils the ability to:

1. Select the size of bulk tank for the home farm.
2. Select the type of bulk tank to use.
3. Decide on where to purchase a bulk tank.

Analysis: (The decisions to be made and the factors to consider)

1. What size bulk tank do we need?
   a. amount of milk produced
   b. future volume of milk
   c. space available
   d. space needed
   e. need for remodeling or building milk house
2. What type of bulk tank should we select?
   a. types available
   b. cost of tanks
   c. cost of operation
   d. space available
   e. space required
   f. ease of cleaning
   g. agitating mechanism
   h. convenience and labor efficiency
3. Where to purchase the bulk tank?
   a. cost
   b. service available from dealer
   c. delivery and installation service
   d. quality of equipment

Teaching procedures:

Content	Teacher-Pupil Activities (Procedure and Teaching Techniques)
Introduction	1. Briefly tie in previous job on selecting method for cooling milk. 2. Teacher reports practices in county and trends in area. 3. Ask pupils to relate responsibilities for this job. 4. Help students identify decisions to be made and factors to consider in selecting and purchasing bulk tank.
Analysis:	
I. What size bulk tank do we need?	
A. Amount of milk produced	1. Guide pupils in calculating daily production from monthly milk sales, DHIA records, and Farm Business Analysis Charts. 2. Report by teacher on frequency of pick-up.
B. Future volume of milk	1. Request pupils to talk with parents about increase in production or size of herd. 2. Discuss future plans as they relate to an increase in volume of milk. 3. Discussion to determine quantity of milk to be stored.
C. Space available	1. Request, in advance, that pupils take inside dimensions of floor layout in milk house. 2. Chart floor plan on graph paper.
D. Space needed	1. Use flip chart to present: a. space required between tank and wall b. space needed for cleaning tank and surrounding area c. amount of space needed for tank d. amount of space needed for work area in milk house 2. Chart layout and compare with space available.
E. Need for remodeling or building milk house	1. Ask pupils to talk with parents about remodeling or building milk house. Pupils report to class. 1. Delay making a final decision until after considering next decision.
II. What type of bulk tank should we select?	
A. Types available	1. Supervised study on types and characteristics of bulk tanks. Cornell Bul. 899 and commercial literature. Obtain following information on each type: a. method of refrigeration b. electrical power requirements c. sizes of refrigerating units d. capacity of tank in relation to overall dimensions 2. Discuss advantages and disadvantages of each type.
B. Cost of tanks	1. Assign pupils to obtain costs, sizes, and types of bulk tanks from local dealers. Also pick up any printed material on bulk tanks. 2. Class discussion to compare costs of each type.
C. Cost of operation	1. Teacher presents information on cost of each type.
D. Space available	1. Use data obtained under 1c and relate to each type of bulk tank.
E. Space required	1. Use data collected previously under 1d and compare space needed and location for each type.
F. Ease of cleaning	1. Guide pupils in obtaining information from commercial pamphlets on shapes of tanks; relate to cleaning.
G. Agitating mechanism	1. Direct study of commercial literature on types and convenience of use.
H. Convenience and labor efficiency	1. Give three boys assignment to obtain facts on height, strainer openings, covers, and ease of using bulk tank. Pupils report to class. 1. Conduct class discussion on basis of factors and information assembled for each factor to arrive at the size and type of bulk tank to use.
III. Where to purchase the bulk tank?	
A. Cost	1. Use costs previously collected (2b) and record in chart form on chalk board.
B. Service available from dealer	1. Class discussion to consider: a. trained personnel b. quality of service c. size of business and future potential
C. Delivery and installation service	1. Assign individuals to survey dealers to determine: a. delivery service provided b. cost c. successful installations

D. Quality of equipment	1. Class discussion
Pupil farm job plan:	1. Guide students in arriving at decisions with justifications.
	2. Students write up farm job plan.
	3. After plan is checked by teacher, pupils take plans home for approval by parents.

References:

Bulk cooling and storage of milk on the farm. Cornell Extension Bulletin 899.

Bulk handling of milk. U. S. Steel Publication.

Requirements and recommendations for milk houses with bulk tanks. Cornell Agricultural Engineering Bulletin 326.

The Demonstration Method of Teaching

As already mentioned, the demonstration method is best used in teaching pupils how to perform manipulative operations. In teaching skills, the teacher is concerned that the pupil learn: the logical step-by-step procedure in doing the job, the principles that apply, and the related information. The ideal conditions for learning a manipulative skill prevail when the learner can observe the procedure at the same time that he hears the explanation. Understanding the principles and related information make the procedure more clear and meaningful to the pupil. As he develops an understanding of what is taking place and why, he will develop an appreciation for performing the skill correctly. For instance, in the use of the oxy-acetylene torch, the problem of oxidation is critical. When cutting steel, rapid oxidation must take place and the metal must be red hot for it to happen. Thus, it must be preheated with the torch before directing a stream of oxygen on the red hot metal. On the other hand, in fusion welding, oxidation must be kept to a minimum. In soldering and brazing, oxides must be removed and oxidation prevented. The many facts that apply and relate to the procedure in performing jobs are an essential part of the demonstration.

It is an important part of the demonstration method that as pupils are taught the skills, they learn the names and uses of the tools.

The demonstration method of teaching involves two major phases: preparing to give a demonstration, and giving the demonstration. This very important and effective method of teaching is outlined below.

How to Give a Demonstration

I. Preparing to give a demonstration
  A. How to get ready to instruct learners:
    1. Select suitable jobs, considering:
      a. jobs to be done, complexity, risk, and frequency
      b. ability of the learners
      c. need to learn skill
    2. Set up objectives for teaching—abilities pupil should develop.
  B. Break down the job:
    1. Select important steps.
    2. Pick out key points.
    3. Select the information associated with the steps.
  C. Think through how to give a demonstration to determine:
    1. How you will prepare the student.
    2. How you will teach him.
    3. How you will try him out.
    4. How you will follow him up.
  D. Have in readiness:
    1. Proper tools, equipment, and materials.
    2. A work place for comfort and efficiency.

II. Giving the demonstration.
  A. Step 1—Prepare the learner:
    1. Put him at ease.
    2. Find out what he knows about the job.
    3. Explain importance of job.
    4. Get him interested in learning job.
    5. Place him in correct position to observe job.
  B. Step 2—Teach him the job:
    1. Tell, show, illustrate, explain, and question carefully and patiently.
    2. Take one step at a time.
    3. Stress key points.
    4. Present information associated with and related to job.
    5. Emphasize safety factors.
  C. Step 3—Try him out:
    1. Have him do job—guide him if necessary.
    2. Have him do job again, explaining steps, key points, and safety factors.
    3. Ask questions and prevent errors.
    4. Repeat until you know he knows.
  D. Step 4—Follow him up:
    1. Put him to work
    2. Check often—encourage questions.
    3. Tell him where to get help.
    4. Explain what to do in an emergency.

Note: The procedure is stated as though the demonstration is being given to an individual. It is applicable and intended to be used with a class.

An explanation of some parts of the preceding outline seems necessary. Part I-B is entitled "Break down the job." This is an analysis of the job into the logical steps involved in teaching and performing it, and helps the pupils to identify and remember the steps. The pupils also need to have certain critical, key points called to their attention and to understand them, if they are to perform the job successfully in a minimum

amount of time. The information associated with learning a skill may be acquired before, during, or after the step-by-step demonstration.

Listed under Section II are the four steps in giving a demonstration. The first step, "Prepare the learner(s)", is intended to put them at ease, develop their interest and a favorable attitude, and find out what they know. As a result, the teacher has his objectives in sharper focus.

In Step 2, "Teach him the job", the teacher performs the skill step by step with an adequate explanation and presentation of principles and information (figs. 11 and 12). New terms should be explained. The steps may be presented on the board, a chart, or on mimeographed sheets before giving the demonstration; or the steps may be written on the board by the teacher or pupil as the demonstration progresses. The teacher should have only one way of performing the skill and not confuse the pupils by discussing two or more ways to do it. Show the pupils how easy it is to do difficult operations when they are done correctly. Encourage the pupils by telling them that others they know have mastered the skill. If the demonstration needs to be repeated, a pupil may be able to perform it instead of the teacher. *Caution: Demonstration should be given in a minimum of time*—from 5 to 20 minutes. Seldom should more than 20 minutes be used by the teacher.

Real learning takes place in Step 3: "Try him out." The pupil should have the opportunity to repeat the performance as soon as possible after the demonstration, thus the correct procedure is learned with a minimum of trial and error and an efficient use of time. Though some pupils require more of his time than others, the teacher must guard against giving too much attention to the slow ones. The teacher must be aware of the activities of each member of the class, and as they work individually, move quickly from one pupil to another. If a number of pupils are having difficulty in learning a skill, the demonstration should be repeated. Students who have mastered the skill may assist the teacher with those who have not. Limited facilities may require that the class be divided into work and practice groups. In this way, demonstrations can be given quickly in two to four areas and all the pupils can practice simultaneously.

Step 4 in giving a demonstration is the follow-up or seeing that the pupil obtains additional practice, either at school or on the farm. Those jobs requiring great skill should be practiced further at school under the supervision of the teacher, others can be improved at home.

In many of the jobs with field machinery, tractors, engines, welding, etc. the real practice and achievement will be on the home farm. Operating the tractor safely, for example, may be demonstrated and practiced at school, but the necessary practice to become a good tractor operator is acquired from several months of actual driving under all kinds of conditions and using

Figure 11. A demonstration by the teacher on servicing and lubricating the manure spreader is realistic and practical instruction on a machine that is frequently used.

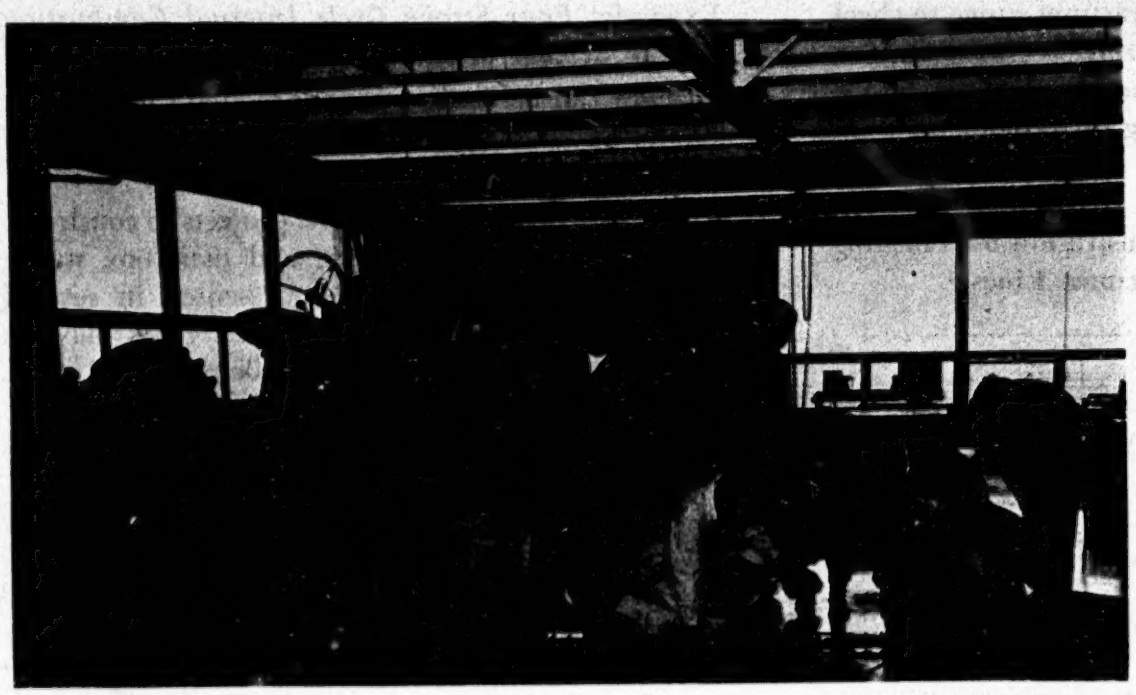

Figure 12. The teacher demonstrates how to check mower cutterbar for lead and how to make proper adjustments.

several of the tractor attachments. The operation of many field machinery units such as calibrating a weed sprayer or grain drill, or lubricating and maintaining machines is learned by performing the job at home with supervision from either parent or teacher.

An example of a teaching plan for the demonstration method is presented below.

Teaching Plan for the Demonstration Method

Unit: Flushing milking machine vacuum lines

Objectives: To develop:

Pupils' ability to check the vacuum pump and lines with a vacuum gauge
Ability to properly clean milking machine vacuum lines
An appreciation of clean vacuum lines

Materials needed:

Milking machine pump and line in place at the farm
Vacuum gauge with hose attached
Four gallons of 2% lye solution
Stanchion hose from milking machine
A quantity of hot water
Milking machine owner's manual

Teacher preparation:

Have all supplies organized and at hand.
Prepare lye solution.
Read instructions in vacuum pump manual pertaining to vacuum line.
Have on hand a supply of Cornell Extension Bulletin 941.
Arrange with farmer for field trip.

Giving the demonstration:

Prepare the learner (introduction):

Why do we need to check vacuum at stall cocks?
How often do you flush vacuum line on your farm?
Answer questions 1–7 on work sheet.

Teach him the job. (Follow the steps below in giving the demonstration. Include key points and information under each step.):

Steps	Key Points and Information
I. Take vacuum reading at all stall cocks	1. Record vacuum readings
II. Flush vacuum line with 2% lye solution	1. Run 3 or 4 quarts of lye solution through stall cock nearest vacuum pump. Draw 3–4 quarts of lye solution through every 4th stall cock. Make provisions to draw off lye solution at pump and use it again at next stall cock. Lye is caustic—avoid drawing solution into pump.
III. Rinse line with warm water	Make sure water solution is drained from sags in low spots in line. Line might have to be taken apart if drains are not provided.
IV. Adjust regulator to give recommended vacuum reading	Check vacuum reading at stall cock nearest vacuum regulator. Compare with recommendations in owner's manual. Variations in makes.
V. Check vacuum reading at each stall cock	Stall cocks not having recommended reading should be flushed individually and may have to be taken apart for cleaning.

Try him out:

Pupils assist in doing steps listed above. Pupils record steps in flushing vacuum lines.

Follow up:

Review demonstration in class next day.

Encourage students to use vacuum gauge to check vacuum lines on home farms.

Have students flush their vacuum lines and adjust vacuum regulator according to recommendations for their machine.

Work Sheet to Use With Demonstration on Flushing Milking Machine Vacuum Lines

1. Name of farmer or farm _____
   Date _____
2. Number of cow stanchions ___ Number milking ___
3. Has there been milking machine injury or mastitis trouble? _____
4. Make of milking machine _____
   Recommended vacuum _____
5. Number of milking units _____
6. Date that the vacuum line was last cleaned or flushed _____
7. On back of this sheet, record vacuum readings at each of stall cocks in order taken.
8. Outline procedure used in demonstration on flushing milking machine lines. Pupils record steps in flushing vacuum lines.

TECHNIQUES OF TEACHING

There is a large variety of techniques that may be used in teaching agricultural mechanics. A few of the useful ones are: charts, consultants, field trips, filmstrips, slides, movies, home assignments, instructional sheets, machines, cutaways, completed projects and others. This section will deal with the presentation, explanation, and use of teaching techniques.

Charts and Pictures

Charts and pictures are valuable teaching aids. Charts may be used for identification or for illustrating principles where the actual materials or objects are not available. However, they should be simplified, realistic, and large enough to be easily seen. Charts are valuable when trends need to be emphasized, when processes are important, when comparisons are needed, or when figures or statistics predominate.

These teaching aids may serve a number of purposes, a few of which are suggested below.

1. They are effective in identifying and testing the pupils in the identification of parts, tools, and supplies.

Examples: *Better Fastenings for the Building Trades,* Independent Nail and Packing Co., Bridgewater, Mass. *Nail Chart,* American Steel and Wire Co., Chicago, Ill.

2. They can be used for showing principles of operation.

Example: *Four Stroke Cycle Internal Combustion Engine* by Case or International Harvester.

3. They can be used to present factual information.

Examples: *Saw Dust Sam Pictures on Farm Safety* by Case. *Don't Watch the Arc*—posters by Airco.

4. Pictures can be used to show projects to construct.

Examples: Feed cart, trailer, and mail box stand.

Charts and pictures may be presented in several ways in the classroom or shop. Some types may be posted for reference use, others will be presented when they fit into the teaching. When presenting a chart before a class, these points should be given consideration.

Be sure everyone can see the chart.

Face the pupils and talk to them.

Use a pointer to indicate points.

Go through all the points on a chart first at a good pace to show continuity. Then, take each point at a time for comprehension and application.

It is your interpretation that the students will see. Emphasize essentials, work in extras, and use common sense.

Select a student and have him explain important points.

Use charts to help pupils learn parts and relationships when giving demonstrations.

Consultants

Even an experienced teacher of agriculture is not equipped to teach all the knowledges and skills in agricultural mechanics. The new teacher especially must rely on the use of consultants to give much of the information to the students, but at the same time he is increasing his own knowledge and ability as an instructor. The local farm machinery service man, welder, electrician, electrical power company agricultural representative, soil conservationist, field machinery block men, factory service representatives, farmers, and others are specialists in their field. They possess the ability to perform many of the skills needed in servicing farm machinery, power and electrical systems, appliances, and to take care of soil and water management problems. These people most likely will be glad to assist in teaching selected jobs when asked (fig. 13).

Teachers are somewhat reluctant to call upon consultants lest it lower their standing and prestige in the eyes of pupils and parents. Generally speaking, people are grateful to teachers and accept the use of consultants. After all, the teacher works out the arrangements and makes the instruction possible.

Consultants usually feel honored in being asked to assist with the teaching of high school pupils and young farmers, but they must be contacted in advance. The

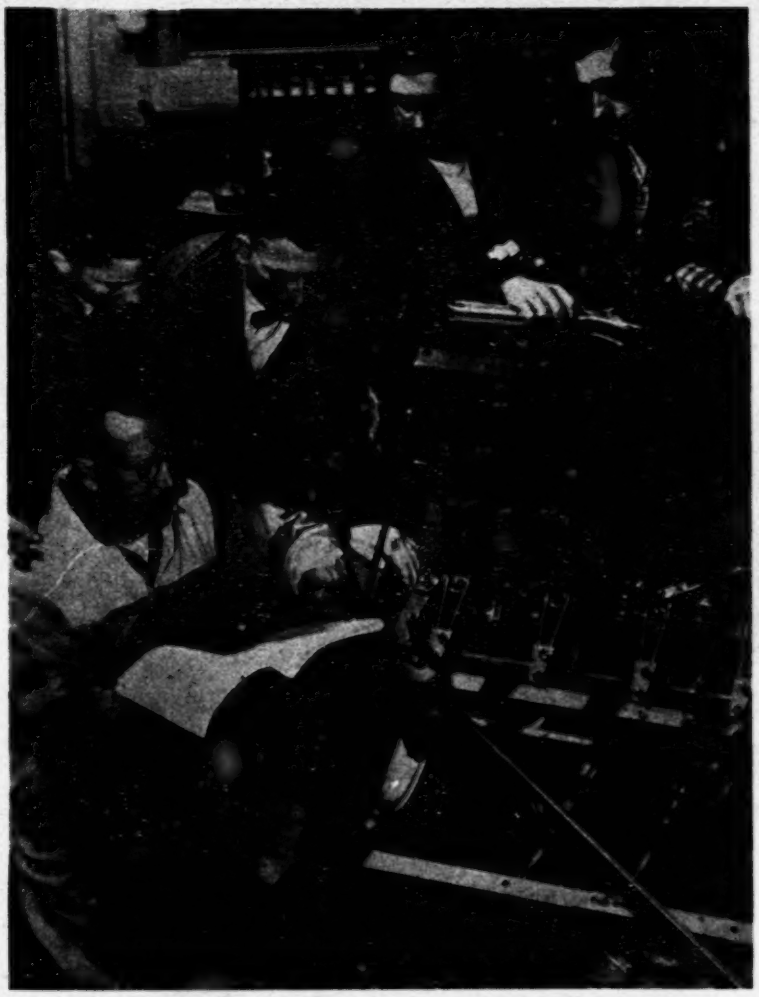

Figure 13. A teacher of agriculture using a consultant to assist in teaching field machinery operation and maintenance. The consultant uses the manufacturer's manual as a reference.

teacher of agriculture must outline with the consultant the specific content desired and give him some assistance in planning his teaching procedures. There is the added advantage that these men bring to the school equipment otherwise not available (fig. 14). Farm machinery factory service representatives and block men may be obtained through local dealers.

Field Trips

Field trips can be a very valuable teaching technique but are justified only when the desired outcome can be attained more effectively and efficiently than in any other way. Often there is a more efficient use of time if the equipment is brought to the school. However, jobs such as making proper field adjustments on the plow, calibrating the weed sprayer (fig. 15), and adjusting the row crop cultivator can be taught most effectively by making adjustments under field operating conditions.

Filmstrips, Slides, and Motion Pictures

Filmstrips, slides, and motion pictures may be used to reinforce teaching methods. For example, it is impossible to see what is happening inside an engine or in the hydraulic system of a tractor when it is running, but a motion picture can show this action vividly. A film may be used to supplement the demonstration in helping individuals to obtain a better understanding of a manipulative process. Films designed to teach a specific unit (e.g., making concrete) give information

Figure 14. The local service man demonstrates the operation of a water pump to a class.

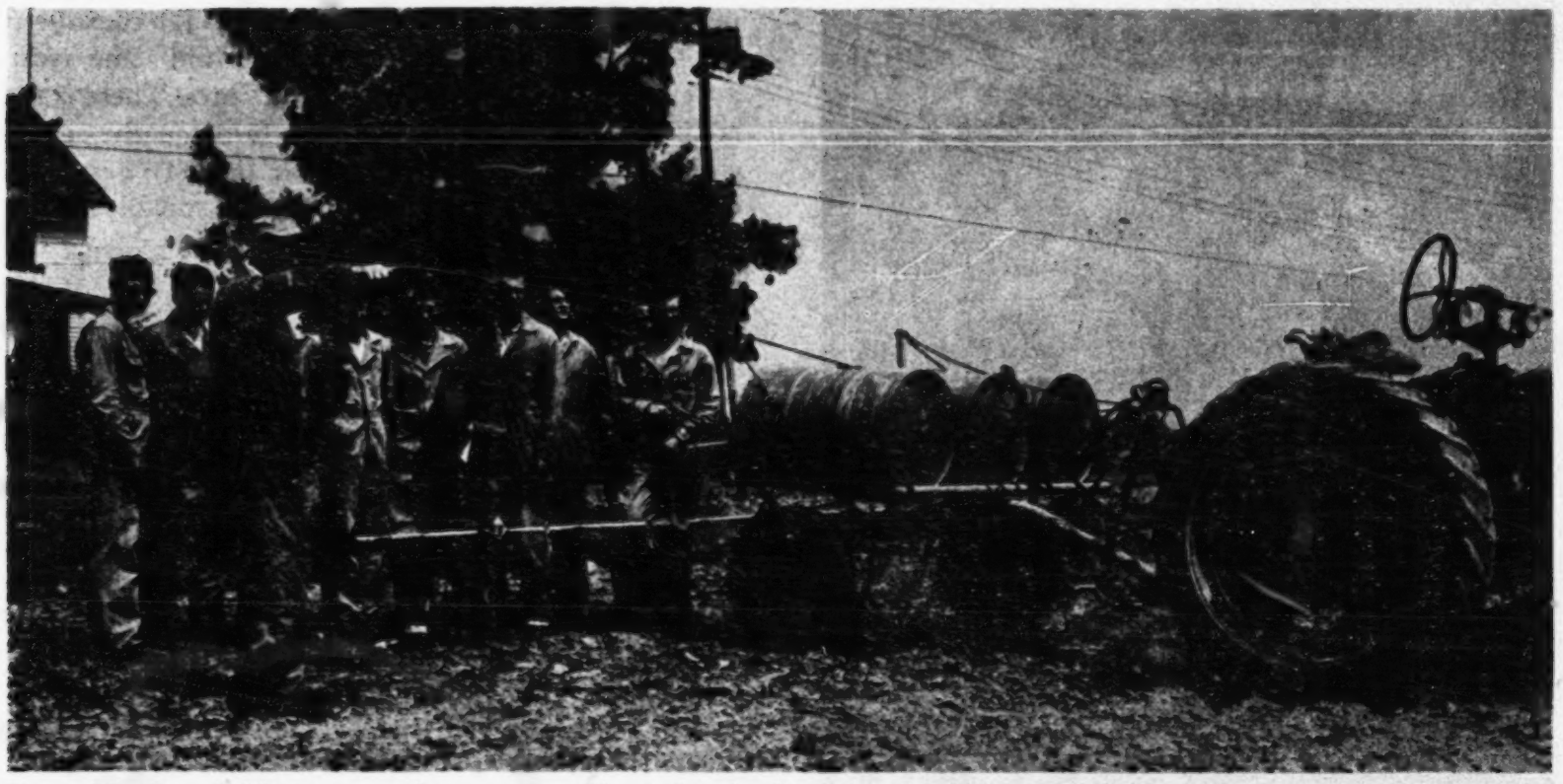

Figure 15. On a field trip, a weed sprayer is calibrated and adjusted under field operating conditions.

and understanding effectively but are limited in number. In selecting films, refer to *Selected Lists of References and Aids in Teaching Agricultural Mechanics* by Bail. Use a film list that indicates the purpose for which the film may be used and its value in teaching.

Slides and filmstrips are preferable to motion pictures for most purposes because they are more readily available, cheaper, and more adaptable in use. Motion pictures must be ordered so far in advance that they are often not on hand at the desired moment. Individual schools can afford to buy a supply of slides and filmstrips because prices are low, some being available free of charge. The projector for filmstrips can be operated at the speed needed for emphasis upon each picture. However, when motion is an important part of the job being taught, a motion picture is more valuable. For example, the General Motors film on *The A B C of Internal Combustion Engines* is an excellent way of showing how an engine operates.

Points to remember in using motion pictures, slides and filmstrips are:

Always preview the film or filmstrip.

Make sure projection equipment is ready to operate properly.

Tell pupils what to look for in film before showing it.

Show film. Back up and repeat important information not fully understood or to emphasize important facts.

Relate information to job being studied.

A demonstration is more realistic, practical, and vivid to pupils than pictures; use it in preference to a visual aid whenever possible.

Home Assignments

Limited use has been made of home assignments because of the double period in school, the lack of adequate references applicable to problems being studied, and the work done at home on the supervised farming programs. In recent years, subjects are being taught in a single period and the class period is being used for laboratory work, therefore it becomes more important and necessary that pupils supplement the class work with study and work outside of school.

Home assignments in the field of agricultural mechanics are of three major types. First are the assignments dealing with the gathering of factual information about the home situation that help boys learn to make decisions and develop plans. Second are reading assignments. Boys should be encouraged to go beyond the minimum in learning information that is associated with a demonstration, and an enthusiastic teacher can encourage pupils to study on their own outside of class. Third is the follow-up—performing at home the skills taught in class or applying the management decisions on the farm. These may be called practice or work assignments designed to increase the pupils' knowledge and abilities in performing farm jobs (fig. 16).

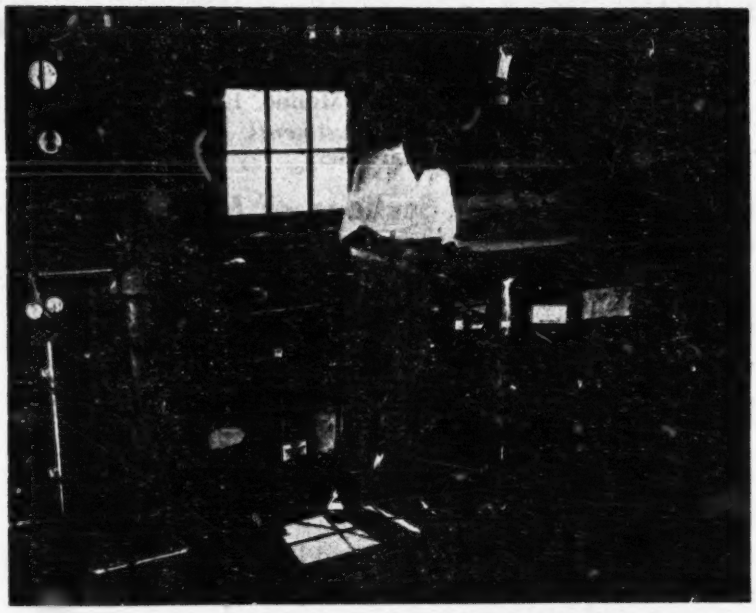

Figure 16. Students develop their skills further by using them on the farm.

Pupils seem to have a natural interest in agricultural mechanics and therefore can easily be encouraged to work and study this subject outside of class. Most parents respect such assignments and will accept responsibility for assisting the boy. They have a higher regard for a course when their children have homework.

Instructional or Plan Sheets

At times, references are not available to provide suitable information related to a specific job, or the procedure for performing a job is not available. Instructional sheets prepared by the teacher can be of great value when facts are needed or directions would facilitate the learning process. The types and nature of these sheets are given below.

Job or operational sheets usually prepared by the teacher:

This type deals directly with the procedure for doing a definite job or operation such as lighting and shutting off an oxy-acetylene torch, calibrating a weed sprayer, or preparing an engine for storage.

Instructions should give step-by-step procedure for doing job.

Illustrations and diagrams may be helpful in explaining procedures.

Questions may be used at beginning and/or end of sheets to stimulate interest.

An operational sheet may be given out for pupils to study before teacher gives demonstration. Pupils can follow it as teacher gives demonstration and as they perform job.

Sheets may be taken home by pupils to serve as a guide in doing job on home farm.

Sheets may provide space for pupils to record observations and results of jobs. For example, a sheet might tell how to calibrate a grain drill and provide space for pupil to record results of operation.

Informational sheets prepared by teacher:

These sheets are used by the teacher when a good reference is not available for information on a specific job. For example, a sheet may be used to explain:

Types of lubricants for tractors
Grades of lumber
Types and characteristics of electric motors

References may be listed for additional information.

Questions may be used at the beginning or end of sheet to promote thinking and guide pupils' study.

Pupil plan sheet worked out by pupil or class:

One of the primary purposes for this type of plan sheet is to have pupil think through the job, know what he is going to do and procedure he will follow in performing an operation or constructing a project.

Plan is drawn up by pupils individually or as a group before starting a construction or repair project.

Pupil should have sketch of project, bill of materials, and order of procedure in doing project or repair work.

Sheet should be checked by instructor before pupil starts project.

Project plans:

A file should be set up with a classified index to keep plans of projects that may be constructed in school or on the farm.

Plans for common projects may be developed by teacher and duplicated for individual use.

Project plans may be obtained from magazines and bulletins.

Collect plans from departments in colleges of agriculture and especially agricultural engineering departments.

Pupil Job Operation Sheet:

Machine: Mower

Job: Reconditioning cutterbar

Part I. Checking cutterbar for needed parts

Check clearance between knife holders and sections. Refer to chart.

Check clearance between knife bar, wearing plates, and guards. Refer to chart.

Remove knife from cutterbar. Is a new one needed or new parts? Record kind and number needed.

Check to determine needed parts. Using a parts catalog, determine make and model number and make a list of kind and number of parts needed.
Wearing plates Knife holders
Guards:
Check wings, lips, and shoulders
Number of new ones
Number of ledger plates
Ledger plates for inner and outer shoe
Guard bolts:
Long Short
Remove guard bolts, knife holders, and wearing plates.
Mark location of knife holders.
Further check condition if there is any question about any part.
Place parts in container.
Order supplies and parts.

Part II. Assembling and adjusting parts on cutterbar

Replace sections in the knife (if needed).
Replace ledger plates (if needed).
Replace guards between knife holders. Tighten up securely.
Replace guards, wearing plate, and knife holders. Leave nuts on guard bolts relatively loose.
Place knife through guards on cutterbar. Use a knife that is not worn.
Begin with wearing plate at outer end of cutterbar. Adjust wearing plate so knife is moved forward against guard, allowing slight clearance but not binding.
Tighten guard bolt.
Move knife back and forth to make sure it does not bind.
Come in to next wearing plate on cutterbar. Adjust. Continue until all have been adjusted and nuts tightened.
Adjust guards up and down so ledger plates are on same plane. Begin on outer end of cutterbar:
Pound high ones down first.
Pound low ones up last.
Drive guards up or down with three- or four-pound hammer.
Adjust knife holders so sections of knife are held down on ledger plates.
Begin on knife holder on outer end of cutterbar. Use strip of sheet metal for gauge.
Pound down with hammer. Use heavy punch and hammer to pound up or *strike holder on flat surface.* Take knife out when pounding holder down.
Adjust guard wings—swage together firmly.
Adjust lips on guards—*leave lip up.*

References:

Operator's Manual

The Operation, Care and Repair of Farm Machinery, 28th edition. Deere and Company, Moline, Illinois.

Crossection of Guard and Adjustments. Charts from John Deere or International Harvester.

Machines, Parts or Sections of Machines, and Projects

The instructional program in agricultural mechanics may be made more dynamic through the use of actual materials. Machines, individual parts, or sections of machines make a vivid impression upon both boys and adults and enliven a demonstration. Through the use of the real machinery, the instruction can be better understood and applied. Some of these teaching aids can be accumulated more rapidly and cheaply than might be supposed; a year or two is often time enough to lay in an adequate supply.

Parts and Sections of Machines

However, since some of the machines on which pupils work are complicated and costly, sections of machines may be used to develop an understanding of the machine and its operation and to provide practice before working on regular equipment. Sections of machines may be cutaway or stripped down to illustrate hidden functions. Worn parts illustrate the lack of proper care, lubrication, or improper adjustments. The following list indicates a few of the parts and sections of machinery that may be used in teaching.

For examples of wear, improper lubrication, and improper adjustment:

Wheel and other bearings Spark plugs
Burned valves Cutterbar parts
Plow shares and mold boards
Knives from harvesters and balers

Practice items—to tear down and reassemble:

Distributors Starters
Generators Carburetors
Magnetos Portable single cylinder engine

Cutaways:

Battery Brake unit
Air cleaner Carburetor
Oil filter Water pump and foot valve

Mounted units and sections of machines:

Corn planter seed box and plate mechanism
Operating knotter Generator

Actual Machines

The use of actual machines is an excellent and practical approach in teaching certain phases of agricultural mechanics. They are an essential part of the instructional program. Since the schools can neither

afford the money to purchase nor the space to store large pieces of farm machinery, some machines can be brought from home by the boys; large pieces of field machinery may be borrowed from farmers nearby the school or seen in the farmers' fields. Dealers will also make others available for demonstrations and servicing. Naturally, care must be taken not to damage any borrowed equipment and to return it on time.

Projects and Exhibits

Young, inexperienced pupils have difficulty in visualizing and drawing a project to be constructed. Studying real projects completed by former pupils give the beginner a perspective so that he has a better idea of what he is going to do or construct.

Closely allied with completed projects are exhibits. They can show not only finished products, but factors such as causes of waste, results of good and poor workmanship, and the effects of breaking safety rules. Effective exhibits are simple and centered around a theme or a point to be emphasized. Certain small items could be displayed in the shop, such as: fillet welds, hardfacing, sawhorse, and grain scoop. Large projects that could not be kept in the school shop might be seen on nearby farms. These could be projects such as feed carts, forage boxes, feed bunks, and individual calf pens. When the actual projects are not available, large photos of the projects are helpful to the pupils.

Students Assisting With Instruction

In teaching skills, student assistants may be used in an instructional or supervisory capacity, under the teacher's supervision. These assistants may be drawn from one of several groups: advanced students, those who have learned the material in other courses or at home, or those who have learned faster than others in the class. They may be used to assist others who are less proficient. For example, a pupil learning to run a bead in arc welding may benefit by having another student check for correct angle, proper distance, etc. A pupil may assist another in learning a skill or give a demonstration to other members of the class. However, care must be taken to make sure the students are able to perform the demonstrations and to give the necessary follow-up.

The use of student instructional assistants may also be valuable to the pupils who are teaching, if done with caution and moderation. This kind of experience helps develop the pupils' interest in learning beyond the regular assignments. Because of their involvement and participation they become more responsible and may learn more than the other pupils. On the other hand, the role of pupil assistant may be detrimental if the student is not really competent enough to perform it.

Testing and Evaluating Pupil Performance

Tests may be used for several purposes. In this discussion, consideration will be given to tests as a measurement of information learned, skills acquired, and jobs done. Tests tend to keep the pupils alert as well as to let them know to what extent they are achieving the objectives established by the teacher.

Testing for information

Pupils should be expected to learn a reasonable amount of information about managerial decisions and skills. The use of short quizzes is one way to make an evaluation. Another is to observe to what extent the pupils are able to do and to apply the information to specific jobs.

Testing skills

Since much of the agricultural mechanics work consists of teaching skills, the teacher must be able to grade the pupils on their ability to perform the skills that have been demonstrated. The best test comes in the actual performance either in the shop, or preferably on the farm where the pupil can demonstrate his ability to use the skills he has performed on a limited basis at the school. There is no test equal to turning out projects, materials, or finished products that exhibit skills and procedures properly learned.

Maintain high standards

It is the responsibility of the teacher to hold the pupils to high standards. The completed projects should be carefully evaluated. The good features should be pointed out to the pupils and the weaknesses also should be made known to them, with instruction as to how they could be improved. Pupils will usually try to perform up to the expectations of the teacher. The teacher should not forget that the real test of his ability is the level of achievement of his pupils, and that the people in his district will judge him on this basis.

Using a Standard Operational Procedure

There is much merit in a standardized approach to work. From the simple job of servicing spark plugs to that of adjusting a combine, a standard procedure is desirable. Care, operation, and maintenance of machinery, as well as repair and reconditioning, should have a sequence of approach in learning the job. Since not every machine repair job can be taught in the agricultural mechanics shop, teachers should train pupils to follow a standardized procedure to establish work habits that carry over from one machine to another. The ultimate goal of our teaching is to develop an individual who is able to work on his own wherever he may be.

Two suggested procedures are given below for the care, operation, and maintenance of field machinery; and repairing and reconditioning farm power and farm machinery. These suggested operational procedures should be mimeographed so the pupils may have a copy to follow in learning the procedure as he goes through it with a machine.

Standard Operational Procedure for Units in Care, Operation, and Maintenance of Field Machinery

1. Use and understand the owner's manual.
2. Check the condition and function of slip clutches, shear pins, and other safety devices.
3. Calibrate for rate, use, and capacity.
4. Lubricate and service daily.
5. Hitch and operate in the field.
6. Detect signs of wear caused by malfunction of operation.
7. Adjust for wear and/or best operation.

Standard Operational Procedure for Units in Repairing and Reconditioning of Farm Power and Machinery

1. Clean machines or engines.
2. Check for worn or broken parts and order replacements.
3. Disassemble machines when needed.
4. Recondition or replace dull, worn, or broken parts.
5. Reassemble and align parts.
6. Test and make final adjustments.
7. Paint when needed.
8. Lubricate.
9. Test machine in field when needed.

The two standard operational procedures presented above should be learned by pupils. As jobs are taught on the care, operation, and maintenance of a machine, or on repair, the pupils should have a copy of the operational procedure to follow. As the pupils use an operational sheet with a few jobs, the procedure should become fixed in their minds.

Discipline

Discipline problems will not appear when there is a well-planned and well-organized instructional program in the shop. Good conduct and good attitudes result when pupils are engaged in activities that they have selected in cooperation with parent and teacher. Then, the instruction must provide for active participation, for as long as boys are actively participating in worthwhile projects, few discipline problems arise.

A Golden Rule for shop conduct is stated this way: "The real purpose of discipline in shop or classroom is to permit each individual to spend all of his time profitably and to make steady progress. At the same time, each must work as a part of a group without interference from others and without interfering with the progress of others."[2]

Overregulation can slow down progress and create an unfavorable climate for learning. A minimum of clearly defined rules are more desirable and more effective than many rules indefinitely expressed and indifferently followed. A few basic regulations are necessary in the shop: those concerned with safety and those that provide for the orderly routine of shop management. A clear understanding with the pupils will do much to create and establish desirable conduct in the shop.

A teacher is directly responsible for the behavior of each of his pupils and is justified in demanding high standards of deportment. Pupils should understand that the shop is a classroom and not a play room. Practices such as orderliness, quiet behavior, and seriousness of purpose must be followed if the work is to be learned. Boys tend to live up to the standards set by and the expectations of the teacher.

MANAGEMENT OF THE AGRICULTURAL MECHANICS SHOP

The organization and management of the agricultural mechanics shop is of much concern to teachers of agriculture for a number of reasons. First, the shop must be organized and managed so as to provide for effective and efficient instruction. Second, the pupils' attitudes toward shop care are affected by what they observe in school. Third, the school administrators, other teachers, and lay people should have a positive attitude toward the agricultural mechanics instruction and the teacher of agriculture.

Because time is a big factor in keeping the room orderly, the teacher should make use of others to help him do the job. Pupils can make facilities needed in the shop and help to keep the shop orderly and in good operating condition. Generally speaking, the teacher should not be expected to perform service and maintenance functions. The pupils can perform simple tasks such as sharpening many of the tools, but saws, jointer blades, and the like should be sent out to an individual equipped to do this work. The time of the teacher is valuable and should be used for instructional purposes only.

Clean-Up in the Shop

Clean-up is important in shop management. A good shop is also a clean shop. A disorderly, untidy room, with trash accumulating under benches and in corners,

[2] *School shop management.* University of the State of New York, State Education Department, Albany, 1957. P. 50.

tells the wrong story to school administrators, fellow teachers, pupils, and patrons, whereas the opposite speaks very well for the instruction. Pupils will develop a higher respect for the teacher and the work done in agricultural mechanics when desirable and orderly conditions are maintained. Administrators and others frequently find a common denominator in cleanliness and orderliness of the shop and the quality of the teaching being done by the teacher.

The teacher must keep in mind that shop clean-up is a part of the job, shared by all pupils, and not punishment. All pupils must have a specific responsibility. The responsibilities must be rotated so that the kind and quality of the burdens will be equally shared. Pupils should also share in the planning; they can elect shop foremen to supervise and direct clean-up. Wash-up and clean-up should be alternated to avoid congestion at the sinks.

Various methods may be used in shop clean-up, but it is the responsibility of the teacher to adopt the method best suited to his own shop. Usually, the more responsibility pupils have in planning the method, the more successfully it will work. Suggested plans for shop clean-up are listed below.

Basically, one of the first steps in developing a plan is to identify clearly the duties that need to be done. For example: one may serve as shop foreman; others may clean welding benches and check the equipment; check to see that all tools have been returned to the tool panels; sweep off table tops; sweep floor areas A, B, and C; keep the lumber rack in order; and keep the metal rack in order.

The clean-up areas may need to be grouped or classified and then recorded. Make a floor plan to show each area of work.

Develop a system of rotating assignments from one work area or group of duties to another.

One plan is to use a double-disc housekeeping indicator. The duties are listed on the outside disc and the names of the pupils on the inside disc. Then, rotate the inner disc when clean-up assignments are changed (fig. 17).

Another plan is to duplicate on a sheet of paper the clean-up assignments down the left side of the sheet. Then, record pupils' names opposite the assignment. When the time comes to change, use another sheet to record names of pupils opposite new assignments.

Still another plan is to have each boy clean his area and put away the tools he used. This plan needs close supervision by shop foreman or teacher. It is more likely to work well with smaller classes of older boys.

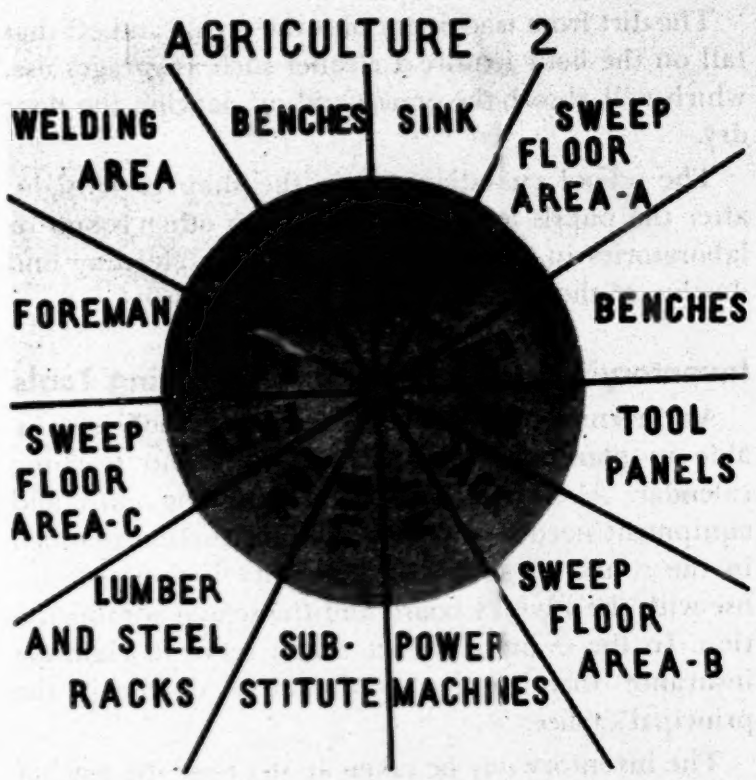

Figure 17. A double-disc shop clean-up indicator. As the inner disc is rotated, the clean-up assignments are changed for the pupils.

The original assignments may be made by the teacher, elected by the pupils, or drawn by lot.

Try to arrange for each pupil to serve in each area or duty an equal amount of time during the year.

Pupils can do much of the work in planning and making up a double-disc housekeeping indicator or assignment sheet.

A shop foreman should indicate clean-up time two or three minutes before the end of the period and then direct pupils in performing their responsibilities. The teacher must assume the responsiblity for the over-all functioning of any plan.

The tools should be returned to place, projects put away, and the shop cleaned up at the end of each class.

The shop should be given a general cleaning each month.

There should be complete clean-up of the shop every year.

In order for the pupils to clean their hands properly after working in grease, oil, and the like, adequate washing facilities must be provided including a grease solvent such as Go-Jo.

A shallow sheet metal pan can be made to catch oils and greases under tractors and other machines, thus avoiding an oily mess on the floor

The dirt from machinery plus the grease and oil that fall on the floor require a cleaner such as garages use, which will absorb the grease and oil, leaving the floor dry.

The school custodians clean the shop each night, after the pupils leave, just as they do other rooms or laboratories in the school. The window cleaning and dusting of the room is also their responsibility.

Inventorying, Identifying, and Retaining Tools

An inventory of shop equipment and tools is valuable in planning the course of study and teaching calendar. Also, it aids in identifying the tools and equipment needed to provide the instruction planned in the course of study. An inventory is desirable for use with the advisory board and the school administration. In the event of fire, it might serve in claiming insurance, therefore a copy should be on file in the principal's office.

The inventory may be taken at any time the teacher or administrator desires, but at least once a year. Below is a suggested form.

Inventory of Tools and Equipment In Agricultural Mechanics Shop

Nomenclature	Cost or replacement value	19—	19—	19—
		Quantity	Quantity	Quantity

Many of the tools in the agricultural mechanics shop are expensive and even small tools add up to several dollars in value. Care should be taken to mark them for identification to help avoid loss. It is suggested that tools belonging to the department be marked by painting with an identifying color, marking with a vibrating tool, or using plastic labels that can be attached to each tool.

Storage in the Shop

The storage of equipment, tools, supplies, clothing, and projects is a problem in a shop. No two will have the same facilities and be able to solve the problem in exactly the same way, however, efficient storage is of primary importance. The following suggestions should aid in solving this problem.

Storage of Pupils' Projects

Difficulties can be avoided by having specific places for each class and each pupil to store projects and machinery; pupils must learn to respect one another's property. Small materials or parts can be easily cared for by placing them in labeled containers and putting them away; but the large projects and machinery create problems. Although normally each teacher must plan out his shop, ways of coping with the problem are suggested below.

Small projects, parts, etc., may be stored in:

Free space under benches
Small overhead storage rack
Cabinets
Free space in locker benches
Extra lockers
Portable storage rack on casters
On top of flat lumber rack

Storage of large projects:

When in use from day to day—on shop floor
When not in use:
- Store outside if mobile and not harmed by weather.
- If practical, develop area in school basement.
- When space permits, put some movable equipment in classroom.
- Develop fenced and paved storage area adjacent to agricultural shop.
- Arrange with service man for a bus garage stall.

Rotate classes so that not all will be working in the shop at the same time.

Storage of Pupils' Shop Clothing

Pupils need to have protective clothing for most of the work in the agricultural mechanics shop. There should be a place, preferably ventilated, where pupils can keep their clothes, such as:

- A portable clothes rack to be kept in the shop.
- Heavy duty hangers mounted on the wall.
- A rod suspended by wires from the ceiling. Use clothes hangers for each individual piece of clothing.
- Lockers located in:
  - Nearby storage area or work room
  - Nearby hall locker area
  - Shop, if space permits

Storage of Supplies

There should be an adequate storage space for the many supply items necessary to this work. Steel cabinets with adjustable shelves serve well for the larger items, while smaller items such as nails, screws, washers, and bolts may be stored in small labeled steel boxes or

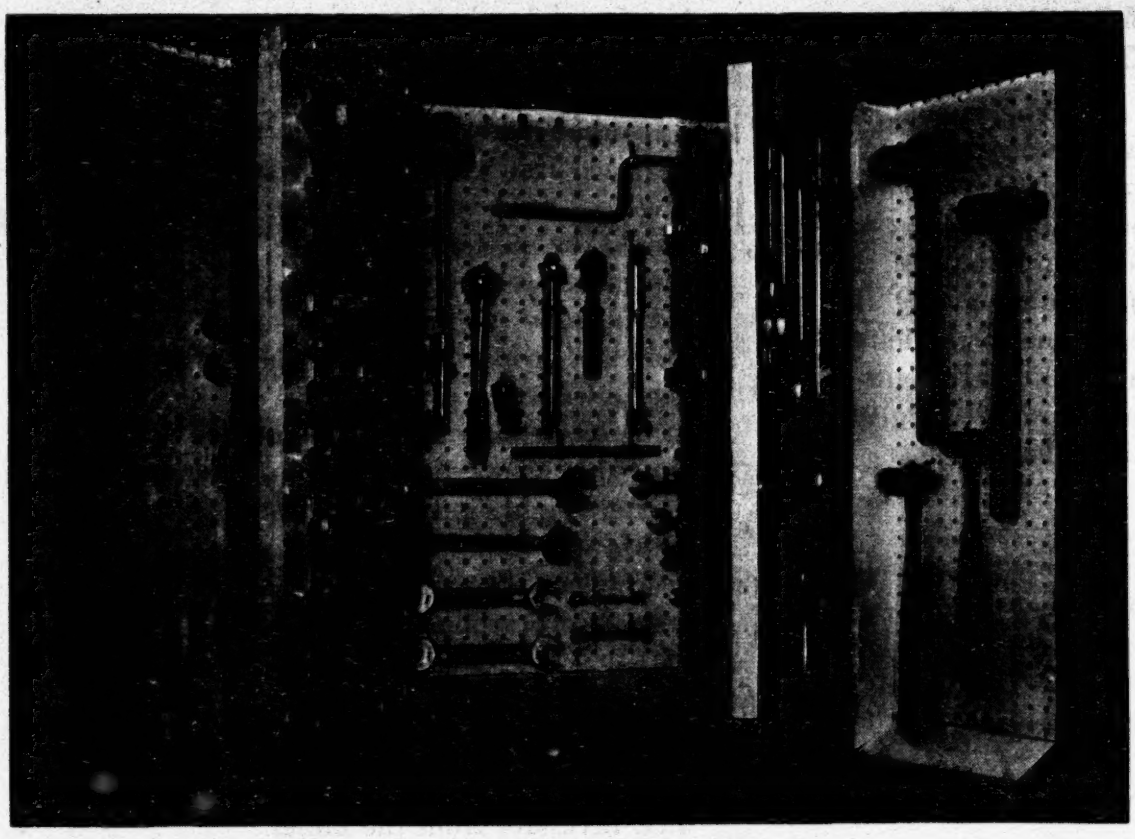

Figure 18. A tool cabinet provides a great amount of storage space on a small wall area. Note the two hinged panels inside the cabinet. (Agricultural Engineering Department, Cornell University).

trays (purchased or constructed), small glass jars, or tin cans. These may be kept in wall cabinets.

Welding supplies may be kept in a steel cabinet near the welding area, or in specially constructed wooden cabinets or shelves along the wall near the welders.

Lumber may be placed in hortizontal racks along walls. Vertical storage of lumber conserves space but limits the length and causes warping of long pieces.

A horizontal rack provides a good way to store steel when space permits. With limited wall space, vertical racks may be used but the length of the steel will be determined by the length of the storage space.

A storage rack or boxes can be constructed and mounted on casters. These are for short lengths of lumber or steel and can be wheeled under a bench for storage.

A small rack or short stock cabinet boxes are desirable for short and assorted pieces of steel.

A small steel drum can serve as a place near the welding area to put scrap metal.

Storage of Tools

Shop tools are generally stored either in the shop or in a tool room. The latter is desirable if an unusually large number of tools are used or where there is limited wall space. Storage of tools in the shop and located in the work areas, is a recommended practice. This method is more efficient because less time is required to obtain and return the tools, but it does create problems in keeping them in place and retaining them in the shop. Yet, these problems are not serious, once they are recognized and practices developed to solve them.

Tools may be stored in the work area in one or more of the following ways:

Wall panels made of peg board or ¾ inch plywood
Cabinets with panels and doors that open out (fig. 18)
Portable tool panels
Caster cabinets or panels for tractor or machinery tools

Silhouettes back of each tool facilitate keeping tools in place and can be used regardless of the storage method. The background for the tools should be a light color and the silhouette of each tool a bright, contrasting color. The silhouettes are either painted on the background or cut out of heavy paper or plastic material and glued on the background.

Pupils who are involved in making storage arrangements and keeping the tools in place obtain great satisfaction in this orderliness. If each beginner has an opportunity to help in keeping the tool storage in top condition, he will develop a sense of pride about it and want to continue these good habits. As a result, fewer tools will be lost.

Valuable testing and precision tools should be kept in a separate room. If such a room is not available, a special cabinet may be used. This helps to ensure the safety and proper use of the tools since they may be checked out only by the teacher.

TEACHING SAFETY IN AGRICULTURAL MECHANICS

To give proper emphasis to the dangers that are connected with a job, safety must be taught as a part of each individual unit. *The correct way of performing a job is the safe way.* The teacher should point out the hazards involved as he performs the steps of the demonstration, stressing the *safety rules,* giving the reason for each, and following each one to the letter.

An important consideration in avoiding accidents is in the physical surroundings. Emphasis will be given to this phase of safety in the sections that follow.

Fire Prevention in the Shop

Provide adequate fire extinguishers for inflammable fuels, wood, and electrical fires.

Locate fire extinguishers in critical places. Keep them in good working order and easily accessible.

Place an extinguisher near the working area when there is a chance of fire.

Teach pupils the use of fire extinguishers and their location.

Avoid the accumulation of trash and excessive amounts of scrap in corners and on the floor.

Store all waste rags in safety cans.

Keep caps on spare oxygen and acetylene tanks and anchor them firmly to avoid tipping over.

Provide adequate ventilation for mixing paint and brush painting. Do spray painting in the open or in a properly ventilated spray room.

Handling Chemicals, Fuels, and Fumes

Many materials used in teaching agricultural mechanics are dangerous to use and store. Fuels and solvents present fire hazards. Some chemicals are caustic. Certain welding operations and the operation of engines produce fumes that are toxic. A few specific hazards and practices to prevent them are presented below.

Use a high flash-point solvent for cleaning parts, paint brushes, and sprayers.

Waste combustibles such as cleaning fluid solvents should be disposed of where a spark will not ignite them. If inflammable materials are dumped down shop drains, gases may accumulate and present a fire or explosion hazard.

Solvents that have been used should be stored in a labeled safety can and then removed from the school for disposal.

The exhaust from operating engines should be removed from the shop by:

Flexible hose from the engine to outside the building

Commercial exhaust equipment

In mild weather an engine may be placed by a large open door with doors and windows open if other methods are not available.

Galvanized iron is poisonous when heated for cutting or welding. Therefore, these operations should be performed in the open or in well-ventilated welding booths.

All dangerous chemicals, such as acids, should be stored in proper containers that are labeled.

Use goggles when pouring acid out of a carboy.

Cutting or welding tanks used to store inflammable fuels should not be done until all fuel has been removed, tanks properly cleaned, and then filled with a non-combustible gas.

Oxy-acetylene equipment must be kept free of oil or other hydrocarbons.

Making the Physical Facilities Safe

Keep all the materials, tools, and litter off the floor.

Mount equipment so that it does not project further than necessary from the tables.

Do not allow floors to become slippery. Once oil or grease is spilled on the floor clean it up. Avoid waxing shop floors.

Place and keep guards around all exposed belts, pulleys, and dangerous moving parts.

See that electrical equipment is properly grounded.

Provide for the removal of smoke and fumes from the shop. Otherwise, avoid having them develop in the shop.

Provide adequate lighting for all working areas and equipment.

Periodically inspect shop equipment to ensure that it is in safe operating condition.

Provide for adequate room to work around shop equipment.

Arrange shop to avoid hazards. Keep inflammable materials away from welding areas. Store materials in shop so that they will not fall on pupils.

Store all fuels and chemicals in labeled safety cans.

Provide master electrical switch to control electrical circuits and operation of equipment.

Proper Dress in the Shop

Special shop work clothing should be worn by pupils. Coveralls or overalls provide maximum protection to the individual.

Do not allow loose clothing such as ties, loose sleeves, torn pockets, sloppy belts, etc. to be worn in the shop.

Require the pupils to wear goggles or face shields when grinding, drilling, and chipping.

Encourage the use of protective clothing such as work shoes and gloves for welding, grinding, and cutting metal and the use of respirators for spray painting.

Safety in Conducting Field Trips

Hazards may develop on field trips so it is well to take precautions to avoid accidents. With this in mind, a few points are presented.

Transportation to places outside the school should be provided by the school. Pupils should not drive their own cars.

Where teachers use their own cars, they should carry adequate insurance coverage.

Well-defined rules of conduct should be explained before and adhered to during trip.

Smoking should not be permitted.

Students should stay together as a group.

Students should be cautioned about specific dangers on field trips, such as moving machinery or parts of machinery.

General Safety Rules

O'Brien[3] gives general safety rules for shop tools, power tools, oxy-acetylene and arc welding, farm machinery, and power. Since these are in a detailed form, it is suggested that the teacher refer to them and have the pupils read and study them. O'Brien gives permission to duplicate these rules for students.

It is a good practice to teach the safety rules at the same time the pupils are learning to use the tools, equipment, or machine to which they apply. This means that the rules would be taught over a period of three to four years. Time given to mimeographing and teaching these safety practices will be as well spent by both pupils and teacher as any other teaching time in agricultural mechanics.

SUMMARY

Agricultural mechanics is an integral part of the instructional program in vocational agriculture.

The teacher of agriculture must have well-defined concepts and objectives that give direction to the instruction in agricultural mechanics.

Effective and complete instruction in agricultural mechanics necessitates a well-planned course of study.

A suggested course of study in the areas of farm power and machinery, farm shop, farm buildings and conveniences, farm electrification, and soil and water management for schools in dairying areas of New York has been developed. It serves as a guide to local schools in developing a course of study to fit local conditions. Schools in non-dairying areas will find much that applies to them in respect to farm power, farm shop, and farm electricity.

The units in the course of study and the teaching time allotments are ambitious in scope, yet indicative of the over-all instruction needed in agricultural mechanics.

Agricultural mechanics is just one phase of the supervised farming programs of the students. The parents should be involved in their sons' supervised farming programs. To the extent the parents know the program and help to plan and develop it, they will be able to help provide their sons with opportunities for learning on the farm.

Group instruction is a more economical and effective use of the teacher's time than individual work with each pupil. More time should be used for group instruction, and pupils should obtain additional practice or apply the facts learned in group instruction to jobs on the home farm.

Managerial jobs can best be taught through the use of the problem-solving method of teaching. Operative (skill) jobs can be most effectively taught by the demonstration method. The latter method should be used increasingly in the future.

A variety of well-selected techniques, used as a part of the teaching method, will make for effective instruction and efficient use of time.

The ever-changing mechanical practices on the farms challenge teachers to use new teaching aids, resources, and consultants to provide up-to-date and effective instruction.

The group instruction at school should be followed by individual, on-farm instruction when pupils need assistance in performing a job taught in class or in learning jobs not taught in class.

An attractive, well-planned agricultural mechanics shop is basic to good teaching. Certain management practices will contribute to effective instruction. A planned, businesslike approach in teaching and shop management will win quick approval from students, school administrators, and others.

Many hazards to the safety and health of both pupils and teacher may develop in teaching agricultural mechanics unless proper precautions are taken to eliminate them. The aspects of safety must be taught with the instructional unit, always keeping in mind that the correct way to perform a job is the safe way. The physical facilities in the agricultural mechanics shop should be arranged and used to the end that accidents are avoided.

[3]O'Brien, Michael, *Demonstrations For Farm Mechanics.* 1957, Interstate, Danville, Illinois. Pp. 25–39.

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